Original Article

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The Functional Tests after ACL Reconstruction with and without Meniscal Repair

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Abstract:

Objective: This study aims to compare the functional tests after anterior cruciate ligament reconstruction (ACLR) with and without meniscal repair after the rehabilitation program and before returning to sports.

Material and Methods: Patients who underwent ACLR using hamstring tendon autograft during 2016-2017 were invited to participate in this study and divided into 2 groups including with and without meniscal repairs according to the surgical reports. A group of ACLR with meniscal repair required the conservative anterior cruciate ligament (ACL) rehabilitation program because the non-weight-bearing approach should be applied during the first 6 weeks. These patients were followed up clinically until the rehabilitation program finished. The functional tests were applied with the 4 single-leg hop tests, as reported in the limb symmetry index (LSI).

Results: Forty-three patients were enrolled in the program. These patients were divided into 2 groups: ACLR with meniscal repair (n=20) and ACLR without meniscal repair (n=23). It was found that there was no statistically significant difference between the two groups with respect to duration for completing the rehabilitation program (p-value=0.38). Also, there was no statistically significant difference between the two groups with respect to the LSI of all 4 single-leg hop tests of duration for completing the rehabilitation program.

Conclusion: The conservative ACL rehabilitation program after meniscal repair surgery did not affect the function tests in terms of duration for completing the rehabilitation program before return to sports (RTS).

Keywords: ACLR, functional tests, limb symmetry index, meniscal repair, rehabilitation

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Introduction

The anterior cruciate ligament (ACL) is the most commonly injured knee ligament which inflicts concomitant injuries to the meniscus accounted for 64.0 to 77.0% of individuals who suffer the ACL rupture and require surgical intervention.[1] Surgeons can perform the arthroscopic anterior cruciate ligament reconstruction (ACLR) along with meniscal surgery. The meniscal surgery options include meniscectomy and meniscal repair. The post-operative management of the ACLR with meniscal repair requires more conservative approach than the ACLR with meniscectomy to ensure the successful treatment outcomes.[2] The rehabilitation program, after ACLR with meniscectomy, does not require a modification of the standard ACL rehabilitation program. On the other hand, the rehabilitation program after ACLR with meniscal repair does require a modified ACL rehabilitation program, because the non-weight-bearing approach should be applied during the first 6 weeks in order to better protect the repair and improve the healing process. Unfortunately, this process causes usually significant muscle atrophy and muscle inhibition during the non weight bearing period, especially in the quadriceps muscle. According to non-weight bearing studies, it was found that the vastus medialis muscles were the first part to atrophy. A systematic review demonstrated quadriceps activation failure was commonly found among patients after ACLR.[3] Quadriceps strength and endurance are very important factors for normal knee joint function. Hence, restoring normal quadriceps function after knee joint injuries is an essential element of rehabilitation. The conservative ACL rehabilitation program with non-weight-bearing approach during the first 6 weeks following surgery might affect the quadriceps strength and the functional abilities of patients' leg.

After the ACLR and rehabilitation, clinical tests including strength testing and laxity measurements does not correlate well with the functional abilities. The functional tests were developed to evaluate surgical and therapeutic outcomes.[4,5] The 4 single-leg hop tests have frequently been proposed as a practical performance-based outcome measurement that reflects the integrated effect of neuromuscular control strength and confidence in the limb.[6] Measurements are performed on both extremities so that test performance on the operated limb and the other limb can be expressed the value as a percentage on the basis of the so-called limb symmetry index (LSI). The LSI was developed by Noyes et al.[7], so as to evaluate the difference between two legs in the functional testing. The LSI >85.0% indicates normal limb symmetry and an abnormal function test score represents a serious risk of physical limitations during sports activities.

The purpose of this study is to compare the functional tests after ACLR both presence and absence of meniscal repair in terms of duration for completing the rehabilitation program and before return to sport (RTS).

This research investigated the potential additive effect of meniscal repair on post ACLR functional abilities. Data from this investigation was clinical outcomes which could determine whether a recovery-focused rehabilitation program should be developed for individuals with meniscal repair surgery.

Material and Methods

Participants

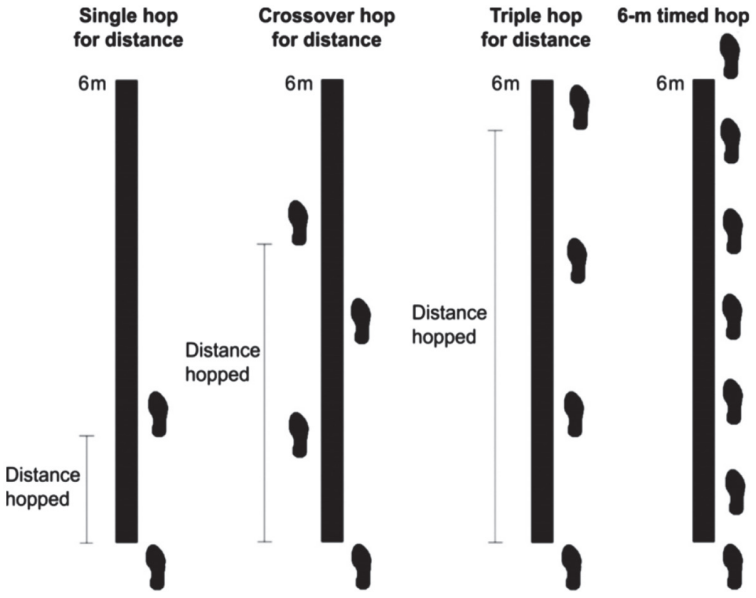
Patients who had undergone an arthroscopic ACLR with hamstring tendon autografts during 2016-2017 were invited to participate in this study (Table 1). All surgeons utilized a similar surgical technique (anteromedial portal drilling, tibial screw fixation and femoral endobutton fixation). Patient aged between 15 to 50 years old. Patients would be excluded if they had a previous history of surgery (other than ACL reconstruction) to either knee, had suffered a previous ACL injury or had a known heart condition. Pregnant females were also excluded. Surgical reports were

obtained in order to report any concomitant meniscal damage that required surgical intervention (Table 1). Details of the post-operative home-based rehabilitation program are illustrated in Appendix 1.[8,9] All patients completed standard post-operative rehabilitation at the Suratthani rehabilitation outpatient clinic which included seven stages that began during the first post-operative week. Each stage was assigned for evaluating the patients who could complete the rehabilitation goals successfully. The duration for completing a program lasts at least six months after surgery. In general, the ACL rehabilitation program emphasizes full knee extension range of motion immediately and knee flexion including tolerated and progression of functional exercises, quadriceps and other leg muscles exercises, proprioception, balance, neuromuscular control and sport specific exercises. Variations occurred in the ACL rehabilitation programs are based on meniscal repair surgery. A group of ACLR with meniscal repair requires a modified conservative ACL rehabilitation program offering non-weight-bearing suggest on for the first 6 weeks. This study has been approved by the Regional Ethics Committee of Suratthani Hospital.

The 4 single-leg hop tests

After completing a rehabilitation program and before RTS, the patients were examined with a series of 4 single-leg hop tests. The 4 single-leg hop tests included the single-leg hop for distance, triple hop for distance, crossover triple hop for distance over a single line and continuous 6-meter timed hop with maximum effort.[10] The diagram for each hop test is shown in Figure 1. The participants were required to stick their landing to be successful in all the tests. The measurements were performed on both extremities so that test performance on the operated limb and the other limb can be expressed the value as a percentage on the basis of the so-called LSI.

LSI (%)=injured leg/uninjured leg×100



m=meter

Figure 1 The 4 single-leg hop tests: single hop for distance, crossover hop for distance, triple hop for distance, and 6 meter timed hop[11]

Statistical analysis

Data was expressed as mean±standard deviation. A t-test was used to compare the groups. Statistical analyses were conducted using STATA version 12.0 (Stata Corp, College Station, TX). A p-value of less than 0.05 was considered statistically significant.

According to Polit & Hungler, 1995; the semi experimental research's sample size consideration required at least 20-30 members for each group.[12]

Results

Subject demographics

Forty-three patients were enrolled in the program. These patients were divided into 2 groups: ACLR with meniscal repair (n=20) and ACLR without meniscal repair (n=23). The median age and body mass index (BMI) were not different between the 2 groups (p-value=0.86, 0.86). The preoperative sport activity level was significant difference between the 2 groups (p-value=0.04) (Table 1). The ACLR group with meniscal repair had 8 athletic patients (40.0%), whilst the ACLR group without meniscal repair had 3 athletic patients (13.0%).

Duration for completing the rehabilitation program

Mean value of duration for completing the rehabilitation program and before RTS in the group of ACLR with meniscal repair was 32.2 weeks and in the group of ACLR without meniscal repair was 34.3 weeks. Therefore, there was no statistically significant difference between the 2 groups in terms of duration for completing the rehabilitation program (p-value=0.32) (Table 1).

Table 1 Participants demographic data

Demographic data	ACLR with meniscal repair (n=20)	ACLR without meniscal repair (n=23)	P-value
Sex	Male=20, Female=0	Male=21, Female=2	0.17
Age (years)	26.40±9.24*	26.91±9.66*	0.86
BMI (kg/m^2)	23.47±3.52*	23.67±6.37*	0.86
Preoperative sport activity level	Amateur=12, Athlete=8	Amateur=20, Athlete=3	0.04
Duration for completing program (weeks)	32.2±6.57*	34.3±7.02*	0.32
LSI >85.0%	18 (90.0%)	21 (91.3%)	0.88

ACLR=anterior cruciate ligament reconstruction, BMI=body mass index, LSI=limb symmetry index
*mean±standard deviation

Table 2 Limb symmetry index for each single hop test and all 4 combined

LSI	ACLR with meniscal repair	ACLR without meniscal repair	P-value
Single hop LSI	89.58±6.80*	92.74±6.37*	0.12
Triple hop LSI	93.20±6.96*	93.64±5.79*	0.82
Crossover hop LSI	94.00±4.93*	94.55±5.84*	0.74
Timed hop LSI	89.10±8.45*	92.90±8.08*	0.14
All tests LSI	91.47±4.56*	93.46±5.08*	0.19

ACLR=anterior cruciate ligament reconstruction, LSI=limb symmetry index
*mean±standard deviation

The 4 single-leg hop tests

The patients had all test LSI value >85.0%. There were 18 patients in the ACLR with meniscal repair group (90.0%) and 21 patients in the ACLR without meniscal repair group (91.3%). According to the number of patients achieving LSI >85.0% in all tests, there was no statistically significant difference between the two groups (p-value=0.88) (Table 1). In addition, the LSI of all 4 single-leg hop tests showed no significant difference between the 2 groups (p-value=0.19) (Table 2).

Discussion

This study was conducted in order to compare the function test results after ACLR with meniscal repair with the conservative ACL rehabilitation program for non-weight bearing during the first 6 weeks and ACLR without meniscal repair with the standard ACL rehabilitation program before RTS. The most important finding indicated that both groups of patients had no significant differences in terms of duration for completing the rehabilitation program before RTS. Thus, the non-weight bearing approach during first 6 weeks mostly slowed down the initial stages of the ACL rehabilitation program. However, it did not significantly prolong the whole program. Similar results were previously reported by Lepley.[1] There was no difference between the 2 groups in ACLR only and ACLR with meniscal surgery in terms of the duration of time until return to sport. Nevertheless, the means value of duration for completing the rehabilitation program in the ACLR with meniscal repair group (32.2 weeks) was shorter than the ACLR without meniscal repair group (34.3 weeks). The reason for this shorter duration could be explained by the percentage of athletes, as the group of ACLR with meniscal repair had more athletic patients (40.0%) than the group of ACLR without meniscal repair (13.0%). Additionally, these athletic patients had every intention of making a full recovery, and fully cooperated with the rehabilitation program, as they wanted to return to their respective sport as soon as possible.

The ACL rehabilitation program had seven stages in total. Patients would complete the rehabilitation goals by passing each single stage. The ACLR patients with meniscal repair were limited to the 2nd and 3rd stages activities (step up, toes rise, wall slide and standing single leg) because of their non-weight bearing period. They, subsequently, could be involved in all activities in stage 4 (6 weeks after operation). Most of the patients had slow progress of the program at stage 5 if they did not join in the training program regularly, they could not pass the single leg squat test (SLST). The SLST was assigned to challenge the neuromuscular control and strength of the surgical limb.[13] All patients in the ACLR with meniscal repair group could undergo an intensive training to achieve better strength and proprioceptionas same as the patients in the non-meniscal repair group in this stage. Passing stage 5 meant those patients had good SLST then they could train a sport specific program (stage 6-7).

After completing a rehabilitation program and before RTS, the patients were examined with the function tests outcomes, so-called LSI. The LSI values of all 4 single-leg hop tests were not different between the 2 groups. Also, the number of patients who achieved LSI >85.0% in all tests was not different between the 2 groups. This finding is in agreement with Shelbourne and colleagues[14] who found that there was no difference in quadriceps strength and single-leg hop performance tests of 5 to 15 years post-surgery in individuals who suffered meniscectomy and/or articular cartilage damage as compared to isolated ACLR. Eric and colleagues[15] found that the presence of concomitant injuries was not associated with the recovery of muscle function at the one-year follow-up after ACLR.

The patients had muscle inhibition during 6 weeks for non-weight-bearing period. Their problem could be

solved by intensive training strength, balance and neuromuscular control. In whole rehabilitation program, they could achieve normal LSI. Thus, the effective rehabilitation programs could promote good quadriceps function for long-term healthy knee joint.

Conclusion

The conservative ACL rehabilitation program after meniscal repair surgery did not affect the function tests in terms of duration for completing the rehabilitation program before RTS.

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Conflict of interest

No potential conflicts of interest relevant to this article were reported.

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Appendix 1

Home-based ACL rehabilitation program[8,9]

Time frame	Rehabilitation goal	Activities
Stage1 Week 0-2	ROM full extension Quadriceps contraction Weight bearing as tolerated with crutches Except meniscal repair group non weight bearing first 6 weeks	On knee brace full extension all times Isometric quadriceps exercise Ankle pump SLR (flex, abduct, extend) Stretching hamstring and gastrocnemius muscle Prone hang, pillow under heel Gait training Patellar mobilization
Stage2 Week 2-4	ROM 0-90° Closed chain quadriceps exercise Walk without crutches	Knee brace 0-90° PROM 0-90° Heel slide Prone hamstring exercise Wall slide knee flex 45°
Stage 3 Week 4-6	ROM 0-120° Increased muscle strength and endurance Enhance propioception, balance, neuromuscular control	Unlocked knee brace PROM 0-120° Stationary bike Step up 4"step forward and lateral Toe rises Wall slide knee flex 90° Shift weight, standing single leg
Stage 4 Week 6-8	ROM 0-140° Normal gait pattern Increased muscle strength and endurance With meniscus repaired titrate weight bearing	PROM 0-140° Step up 8"step forward and lateral Wall slide knee flex 90° with weight and ball Wall slide single leg 45-90° Backward walking Leg press exercise (0-60 degree)
Stage 5 Week 8-12	Full ROM Enhance propioception, balance, neuromuscular control Good single leg squat test	Trademill walking (flat only) Forward lunge exercise Wobble board balance two leg Single leg squat
Stage 6 Week 12-18	Full ROM Restore functional capability and confidence Good single leg squat test	Reverse lunge exercise Jogging and light running Knee extension exercise Agility exercise Outdoor bike on flat road
Stage 7 Week 18-24	Maintained muscle strength and endurance neuromuscular control Return to sport	Running, jumping, hoping Agility exercise Sport specific exercise

ROM=range of motion, SLR=straight leg raising, PROM=passive range of motion