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Research Article

The Effect of Functional Tests on Kinesiophobia in Anterior Cruciate Ligament-deficient Patients with Similar Quadriceps Strength to Healthy Controls

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ARTICLE INFORMATION

Article Chronology:
Received: 04.04.2016
Revised: 11.05.2016
Accepted: 24.05.2016

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ABSTRACT

Introduction: Anterior cruciate ligament (ACL) rupture is one of the most common sport injuries. Despite present progresses in conservative and surgical treatment methods for ACL, the rate of return to pre-injury level (RTP) is low. Fear of movement/reinjury (kinesiophobia) is a major hindrance to RTP in these patients. The aim of the following research was to investigate functional tests' effect on ACL deficient (ACLD) patients' kinesiophobia, who do not have significant differences in quadriceps strength, with healthy people. For this purpose, kinesiophobia was measured in these patients before and after functional tests and compared to healthy controls.

Material and Methods: A cross-sectional study was done on 16 ACLD patients who have been injured for at least 3 months to 2 years at the very most and have been under physical therapy treatment and 16 healthy controls. Quadriceps isometric strength, crossover hop, 6 m timed hop score indexes, and kinesiophobia scores were compiled. Patients (n = 16) were divided into two random groups, where Group "A" (n = 8) took the Tampa Scale of Kinesiophobia (TSK-17) questionnaire before functional tests, and Group "B" (n = 8) took the TSK-17 after functional tests. TSK-17 was used to measure kinesiophobia. An analysis of variance was used to compare TSK-17 and other clinical measures between groups.

Results: Comparison of kinesiophobia level between Groups A and B showed a significant difference (P = 0.004). However, between the control group and Group B, no statistical difference existed. Functional tests and muscle strength score indexes between the three groups did not have significant differences. Moreover, activity level and time from injury to evaluation between the two groups of patients had no significant differences.

Conclusion: Based on the results, it could be said that ACLD patients carrying out functional tests may possibly be effective in decreasing kinesiophobia as an important hindrance to RTP level. It appears that the reduction is a result of the patients' increased awareness about their abilities and functional status since their muscle strength was similar to that of healthy controls.

Keywords: Fear of movement/reinjury; Anterior cruciate ligament deficient; Functional test, muscle strength

Citation: Jamshidi AA, Kamali M, Akbari M, Nazari S, Razi M. **The Effect of Functional Tests on Kinesiophobia in Anterior Cruciate Ligament-deficient Patients with Similar Quadriceps Strength to Healthy Controls.** J Mod Rehab 2016; 10(2): 67-73.

Introduction

Anterior cruciate ligament (ACL) rupture frequently causes disability in athletes (1) and usually occurs in sport activities that require sudden turning, jumping, or

pivoting movements (2). ACL reconstruction (ACLR) is a gold standard treatment in the United States of America (3), and there are more than 200,000 surgeries, which annually combines up to over 2 billion dollars (4, 5). Reconstruction is done to stabilize the knee, preventing further damage and returning the athlete to pre-injury level. Although many people after ACLR do not return to the same level as before injury (6-8), some athletes can return to play without surgery (conservatively). Among patients who are treated conservatively, the rate of return to pre-injury (RTP) is from 19% to 82% (9, 10). Despite recent improvements in surgical and rehabilitation techniques to restore knee function, it is reported that 20-50% of ACLR patients do not return to the same sports after surgery (11-14).

In addition, 10-70% of those who resume pre-injury sports participate at a reduced level or with significant dysfunction (11, 15). A literature review showed that only 36% of patients (13-70%) had lower activity level due to knee dysfunction (16-19). Fear of movement or reinjury (kinesiophobia), subsequent damage or contralateral limb injury (13), knee function after surgery, muscle strength, and even financial losses in professional athletes as well as social reasons, in the process of RTP is effective (14). Based on Goh et al.'s (20) study, patients undergoing ACLR alone appear to have better outcomes of return to sport at 6 and 9 months compared to those undergoing additional cartilage/meniscal procedures. These differences appear to be significantly related to kinesiophobia and pre-injury sport participation. Lamott (21) and Morrey et al. (22) provide a vision about psychological factors by surveying athletes' emotional response during rehabilitation with Emotional Response of Athletes to Injury Questionnaire: both studies showed athletes not only experience negative emotions following injury but also they have a secondary increase in negative emotions in the later phases of rehabilitation.

A number of investigators have reported kinesiophobia as one of the important causes of failure in returning to the previous level of activity. Kvist et al. (13) surveyed 62 athletes after ACLR and found 24% of those who still had not returned to the pre-injury level, 3-4 years after surgery, reported fear of reinjury as the cause. Fear of reinjury was reported in 7% (23) and 30% (24) of patients in other studies. The results of these studies show that patients who were unable to RTP level, in comparison to patients who returned to the pre-injury level, had increased fear of reinjury due to movement. Furthermore, knee-related quality of life in these patients was lower than those who could return to the pre-injury level. Fear of reinjury may disrupt the therapeutic effects of surgery and physical therapy (13).

The ligament, in addition to its mechanical role in keeping the knee stable, works as a sensory receptor (25). Therefore, following damage, neuromuscular control in both sides is disturbed due to defects in the nervous system (26). Neuromuscular control can be achieved through an accurate set of active muscle forces and interrelation between the nervous system, muscles, and sensory organs (25). Functional tests assess neuromuscular control, strength, and performance (27) and have high replicability (28). Considering one functional test to assess the patient's level of dynamic performance is not enough, and it is suggested that at least two functional tests be used in the analysis of lower limb function (29). Therefore, in this study, two functional tests, crossover hop and 6 m timed hop, are used. The tests assess patient ability in movements that require knee stability (30).

Hartigan et al. (31) in a survey of relationship between patients' functional status of knee and fear of movement in ACL-deficient (ACLD) patients realized that a reduction in kinesiophobia is related to increased level of knee function over time. In addition, the tests mentioned enable patients to have a better assessment of their functional status.

Extensor system deficit is a common complication in ACL rupture, even after reconstruction and rehabilitation programs. Quadriceps muscle strength is supposed as a factor to cope with injury.

Several electromyography studies have been carried out on patients with ACLD in activities such as walking, side jumping, and single leg hopping. The general conclusion of these studies is that there are differences in copers and healthy people with injured people (26). Therefore, in this study, we have decided to investigate the effect of knee functional tests on fear of movement/reinjury and to compare the results with healthy controls. This study examines the fear of movement before and after the functional tests in patients who for maximum of 2 years and at least 3 months before this study were injured with a completely torn ACL.

Furthermore, to rule out the effect of quadriceps muscle strength as an important intervening factor, maximum voluntary isometric knee extension was measured. Patients who were surveyed were treated conservatively and had good quadriceps strength.

Kinesiophobia was measured by the Tampa Scale of Kinesiophobia (TSK), which is a questionnaire used to quantify fear of movement/reinjury. The validity and reliability of the Persian version of the TSK-17 questionnaire have been evaluated in lower back pain. Measurements of kinesiophobia, before and after functional tests, in patients with normal power of knee extension, and its comparison with healthy controls have not been surveyed until now. Furthermore, fear as a subjective factor can be influenced by cultural factors and beliefs of different communities; hence, it is necessary for kinesiophobia to be examined in various countries, including Iran.

Materials and methods

Participants in this cross-sectional study consisted of

two groups, patients and healthy controls. Convenient sampling includes any patient who has suffered a complete rupture of the ACL during the last 2 years to 3 months before their examination and meets the inclusion criteria.

Patients participating in the study were selected from men and women of ages 20 to 35 years, because in this range, knee degenerative changes in ACLD patients do not happen unless it has been 5-15 years since their injury occurred (32, 33).

It is very important that participants have no sign of osteoarthritis (OA) because Hart et al. (34) observed that those participants with OA following ACLR had lower knee confidence and higher kinesiophobia than those without knee OA. In the OA group, poorer knee confidence was associated with greater kinesiophobia and worse patient-reported and performance-based functional impairments. Hence, in this research, we matched patients with same knee function and status. Complete single unilateral ACL rupture was confirmed by magnetic resonance imaging, and patients underwent physiotherapy to reduce knee impairments including gait deviations, knee joint effusion, knee range of motion limitations, thigh muscle strength deficits (primarily quadriceps strength deficits), knee pain, complete range of motion of the knee, and normal gait which was all part of the inclusion criteria. Moreover, there were patients who were without bilateral injury, concomitant injuries (e.g., other ligamentous injury of Grade 3, full thickness chondral defect of > 1 cm^2), pregnancy, joint infection, history of fracture, and previous knee surgery. The control group, in terms of age and level of physical activity and other inclusion criteria, was similar but did not have ACL injury. Participants were informed about the stages and the research objectives of the study, and so we progressed with their full consent (they had the option of dropping out of the study at any stage). All stages of the research were approved by the Ethics Committee of Iran University of Medical Sciences, and the committee confirmed that none of the stages were harmful to the participants, the rights of the patients were protected, and that all patients gave written informed consent.

Information of functional tests through two tests (crossover hop and 6 m timed hop), and kinesiophobia through TSK-17 questionnaires were compiled. The TSK-17 includes 17 items, with scores ranging from 17 to 68 points, and higher scores indicate higher levels of kinesiophobia.

The sample size was according to the standard deviation of the main variable of the study (kinesiophobia), taken from a similar article to this project (35) with 95% confidence interval. For this purpose, 16 patients were randomly selected. To compare the level of kinesiophobia in patients with normal levels, 16 healthy people were invited and used as a control group.

The patients were classified randomly into two groups of 8 people. For ease of expression of each group, which consisted of 8 people, they are named and referred to as follows: “Group A” a group that first received the TSK-17 questionnaire then performed functional tests, and “Group B” a group that first performed functional tests then received the TSK-17 questionnaire.

Quadriceps strength was measured with an electromechanical dynamometer (Manufacturer of rehabilitative and sport measuring equipment Danesh Salar Iranianversion 1.0.27 - Latest update October 2011) during maximum voluntary isometric contraction of the knee extensors while seated (36). Isometric testing is a reliable and accurate way to measure quadriceps strength (37). The quadriceps strength index was calculated as the force produced by the injured limb divided by the force produced by the uninjured limb, expressed as a percentage (36).

To do a crossover hop test, a tape with 6 m length and 15 cm width was drawn on the ground. At the start point, people must stand on the opposite side of the tested limb. At first, the subjects were familiarized with the type of jump. After enough practice and a decreased sense of danger, the participants would first jump with non-injured limb then with the injured limb. People were asked to jump four times with maximum power in succession on one limb so that every time they cut the tape and jump the maximum possible length. If their foot was on the tape, the test was repeated. Participants completed the test three times with each limb, in intervals of one minute. The average was then calculated. In the 6 m timed hop test, participants tried to reach a distance of 6 m in the shortest possible time with the least number of hops.

A symmetry index crossover hop test score was computed for each hop test by dividing the hop distance by the injured limb compared with the hop distance of the uninjured limb, expressed as a percentage. Because lower numbers indicate better performance on the 6-m timed hop test, the symmetry index for this test was calculated as hop time by the uninjured limb divided by hop time by the injured limb, expressed as a percentage.

Data were analyzed with SPSS Statistics (Version 17; SPSS Inc., Chicago, IL., USA), and descriptive statistics were generated for demographic data, quadriceps strength, crossover hop test, and 6 m timed hop scores. Kolmogorov–Smirnov (K-S) test was used to measure the distribution of the data. Due to the normal distribution of data (parametric nature of our change scores), repeated measures analyses of variance (ANOVAs) was used to compare between Groups “A, B, and control.” If there was a significant difference, then the Bonferroni post-hoc test was used. Statistical significance was set a priori at $P < 0.050$.

Table 1. Mean (standard deviation) of participant demographic features in three Groups A (n = 8), B (n = 8), and control (n = 16)

Variables	Age (year)	BMI (m/kg^2)	Activity level (hour/week)	Time from injury to evaluation (month)
Control	23.06 (2.14)	23.48 (3.98)	5.06 (4.52)	-
A	25.88 (5.89)	25.12 (2.03)	10.93 (4.89)	13.63 (9)
B	29.88 (4.91)	26.12 (4.76)	7.06 (3.69)	8.25 (6)
P value	0.002	0.268	0.079	0.140

P < 0.050

Results

A total of 32 people (16 patients, 16 healthy controls) met the inclusion criteria for this study.

Demographic data including mean and standard deviation of body mass index (kilogram per square meter), the level of activity (hour per week), the elapsed time of injury (month), and gender of the subjects in the three groups for the 32 subjects were analyzed (Table 1).

K-S test indicated that all variables had a normal distribution. ANOVA for the variables in table 1 did not show a statistically significant difference between any of the groups, except the age mean between the control group and Group B (P = 0.002). Knee degenerative changes and loss of function following ACL injury begin after the ages of 35-40 years [33]. Therefore, the study regarding the ACL of those aged between 20 and 35 years will be considered as a homogeneous interval (38).

Descriptive statistics for quadriceps strength index, the 2 hop test indexes, and the self-report questionnaire (TSK-17) were compiled for all 32 subjects and reported for each group in table 2.

All variables had a normal distribution. There were no statistically significant differences between the functional tests and quadriceps strength scores index in the three groups. However, TSK-17 questionnaire scores were significantly different between the groups.

Table 3 shows post-hoc test results for kinesiophobia scores and functional tests and quadriceps strength scores indexes for Groups A, B, and control.

Kinesiophobia scores had a significant difference between Group A and Group B. There were also significant differences between Group A and the control group. However, there were no statistically significant differences between the control group and Group B. Knee functional status, determined by functional tests, showed no significant difference with the control group, as well as muscle strength in patients which were statistically similar to healthy controls.

Discussion

Kinesiophobia is an irrational and excessive fear of physical activity and movement that arises due to the feeling of vulnerability to painful injury or reinjury (39). In this study, kinesiophobia in Group B that filled out the TSK-17 questionnaire after performing functional tests was lower than "Group A" that completed the questionnaire before performing functional tests, and compared with the control group, there was no significant difference (Table 2).

Significant lower levels of kinesiophobia in Group B that received the questionnaire TSK-17 after functional tests could suggest the effect of realizing that their limited capabilities were due to fear of reinjury.

On the other hand, the patients' knee functional status that is determined by functional tests showed no significant differences with the control group, as well as muscle strength in patients which were statistically similar to healthy controls. These findings potentially confirm the hypothesis that kinesiophobia is associated with patients' perception of their abilities more than it is with their performance.

Intervening factors (e.g., injury severity and elapsed time from injury) were ineffective on patients' kinesiophobia. It was expected that decreases in kinesiophobia as a subjective factor in Group B are related to increases in awareness of functional status, which is also a subjective factor.

Interestingly, surveys of orthopedic surgeons in the United States show that they often discuss fear of reinjury with patients, and most of them agree that ACLD patients will be unable to participate in all recreational sporting activities without surgery. Reducing fear of movement after surgery can reflect expectations passed between the patient and surgeon.

There is not one right approach to talk to patients about diagnosis and the pain that they are experiencing; however, there are ways that can be done and can potentially increase the patient's perception of pain and derail your treatment efforts (40).

Table 2. Mean (standard deviation) of descriptive statistics for quadriceps strength index, the 2 hop test indexes, and TSK-17 questionnaire in three Groups A (n = 8), B (n = 8), and control (n = 16)

Variables	Group A (%)	Group B (%)	Control group (%)
Crossover hop score index	32.88 (79.63)	17.49 (81.63)	3.51 (94.25)
6 m timed hop score index	32.79 (78.13)	11.74 (84.38)	3.99 (96.75)
Quadriceps MVIC	14.74 (82.88)	8.56 (87.63)	(90.31)
TSK-17 questionnaire score	6.08 (40.13)	2.86 (28.25)	8.27 (32.38)

MVIC: Maximum voluntary isometric contraction, TSK: Tampa Scale of Kinesiophobia

Table 3. Result of post-hoc test in three Groups A (n = 8), B (n = 8), control (n = 8)

Variables		Crossover hop score index		Score index 6 m timed hop		Quadriceps MVIC		TSK-17 questionnaire score	
Groups		**Significant**	**Mean difference**	**Significant**	**Mean difference**	**Significant**	**Mean difference**	**Significant**	**Mean difference**
Group Control	Group A	0.233	−14.625	0.058	−18.625	0.179	7.438	0.035	7.750
Group Control	Group B	0.376	−12.625	0.331	−12.375	0.789	2.688	0.354	−4.125
Group B	Group A	1.000	−2.000	1.000	−6.250	0.577	−4.750	0.004	11.857

P < 0.050.

MVIC: Maximum voluntary isometric contraction; TSK: Tampa Scale of Kinesiophobia

In addition, this attitude and general view of society that surgery is necessary to return to the pre-injury level may have an influence on high levels of kinesiophobia before surgery and decrease it after surgery (31).

A systematic review in 2015 showed self-confidence, optimism, and self-motivation are predictive of outcomes, which is consistent with the theory of self-efficacy. Stress, social support, and athletic self-identity are predictive of outcomes, which is consistent with the global relationship between stress, health, and the buffering hypothesis of social support (41).

About 40 years ago, it was stated that ACL tear was a "beginning of the end" of the knee (34). Nowadays, despite advances in reconstruction and rehabilitation techniques of ACL, half of these patients are not able to return to the pre-injury level (42). About hindrances of returning to the pre-injury level, Lamott (21) and Morry et al. described athletes' emotional response throughout rehabilitation as a "U" pattern. Negative emotions are not only high immediately after the injury but also increase again when the orthopedic surgeon allows resumption of activity. Psychological responses in physical trauma or injury will occur, and injured athletes often experience negative emotions and lack of confidence due to a decline in physical ability (43). One study showed that lack of confidence in the face of returning objective and subjective knee stability (13). The importance of confidence in returning to competitive sport is vital (44). Physical and psychological readiness to return to sport do not necessarily coincide (45). Among all the physical, psychological, and social hindrances to return to play, kinesiophobia is known as one of the major obstacles. In this study, kinesiophobia was measured through the TSK-17 questionnaire. TSK-17 includes 17 items, and each item is scored on a four-point Likert scale. The score range is from 17 to 68. Higher scores indicate higher levels of fear of movement/reinjury. Validity and reliability of the Persian version are measured in chronic lower back pain (35).

Conclusion

There were significant differences in kinesiophobia between patients who received TSK-17 questionnaire before functional tests with patients who received the questionnaire after functional tests; although the functional status and muscle strength of patients and healthy controls showed no significant difference. This suggests that patients become aware of their potential while carrying out functional tests and realize that their potential was limited as a result of kinesiophobia. They have gained morale and confidence, and it seems that these factors were responsible in the decreased mean of kinesiophobia in Group B.

Therefore, giving objective and accurate awareness of patients' ability to them, through functional tests, can potentially reduce kinesiophobia.

Conflict of Interests

Authors have no conflict of interests.

Acknowledgement

This paper is the result of S. Nazari MSc. dissertation in sport physiotherapy. Special thanks to Dr. Mohammad Razi for referring patients.

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