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The relationship between pain catastrophizing, kinesiophobia and subjective knee function during rehabilitation following anterior cruciate ligament reconstruction and meniscectomy: A pilot study

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ABSTRACT

Background and objective: Psychological responses to the initial injury and rehabilitation might be an important additional determinant of functional level outcomes after knee surgery. The objectives of this study were (1) to measure pain catastrophizing and kinesiophobia levels and (2) determine their association with self-reported subjective knee function during rehabilitation, following anterior cruciate ligament reconstruction (ACLR) and meniscectomy.

Materials and methods: The study involved 41 participants. The levels of catastrophizing (Pain Catastrophizing Scale [PCS]), kinesiophobia (Tampa Scale of Kinesiophobia [TSK-11]), pain (Numeric Pain Rating Scale [NRS]), and subjective knee function (the Knee Injury and Osteoarthritis Outcome Score [KOOS]) were assessed before and after completion of 14-session rehabilitation program.

Results: The mean level of catastrophizing changed from 5.8 (SD, 0.9) to 4.2 (SD, 0.5) during rehabilitation ($P < 0.05$). The mean level of kinesiophobia changed from 22.7 (SD, 0.7) to 18.4 (SD, 0.6) ($P < 0.05$). There was a moderate negative correlation between the PCS and the KOOS pain, function in daily living, knee-related quality of life subscales before and after rehabilitation ($P < 0.05$). There was a moderate negative correlation between the TSK-11 score and the KOOS function in daily living subscale before and after rehabilitation ($P < 0.05$).

Conclusions: Pain catastrophizing and kinesiophobia decreased during rehabilitation. A higher pain catastrophizing level correlated with a greater level of knee pain during activities, more difficulties experienced during daily activities before and after rehabilitation.

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A high level of kinesiophobia correlated with more difficulties experienced in daily activities and poorer knee-related quality of life before and after rehabilitation.

1. Introduction

The most frequently injured ligament of the knee is the anterior cruciate ligament [1,2]. The incidence of anterior cruciate ligament reconstruction (ACLR) in the United States increased between 1994 and 2006, reaching rates as high as 35/100,000 people per year, particularly in females as well as those younger than 20 years and those 40 years or older [3]. These figures are consistent with estimates from both New Zealand (2000–2005) and Scandinavia (2004–2007), which have reported ACL injury rates of 32–37/100,000 [4] and 38/100,000 [5] people per year. In Australia (2003–2008), ACL injury rates have been reported to be as high as 52/100,000 people per year [6]. Meniscal injuries are the second most common injury of the knee, with an incidence of 12%–14% and a prevalence of 61 cases per 100,000 persons [7]. A high incidence of meniscal tears occurs with an injury to the anterior cruciate ligament, ranging from 22% to 86% [8,9]. In these cases, the surgery is performed to stabilize the knee joint to prevent further injuries and to allow the patient to return to previous level of activity. After surgery, rehabilitation helps to restore range of motion, strength, movement control, and knee function [10]. During rehabilitation, not only physical but also psychological factors could be an indicator of rehabilitation success.

In recent years, the integration of the biopsychosocial model in rehabilitation has been receiving attention in clinical research. Implementing psychological factors assessment and management in rehabilitation for patients with musculoskeletal injuries/pain can aid in the decision making process and improve outcomes. Therefore, it is important to know which psychological factors are related to the rehabilitation process and can contribute to a good recovery. The psychological influences such as self-efficacy, confidence in function, pain catastrophizing, kinesiophobia or re-injury may modulate individual perception and response to the illness, and may influence functional level after musculoskeletal injury [11–16].

Kinesiophobia causes patients to avoid behaviors that may potentially elicit pain or re-injury. The injury can create feelings of uncertainty and fear of how far the injury will affect future function [17]. This causes the individual's negative attitudes toward the body and participating in daily activities and sports. Pain catastrophizing and fear of pain is a major cause of delayed recovery and discharge after musculoskeletal injury and surgery [18,19]. Pain catastrophizing reflects an exaggerated negative cognitive and affective reaction to an expected or actual pain experience [20]. It is characterized by magnification of the potential negative aspects of pain, an inability to disengage from thoughts about pain, and feeling of helplessness in coping with pain [21,22]. These misinterpretations and pain-related fear often cause avoidance, escape and guarding behaviors [19]. Kinesiophobia is described as an excessive, irrational and debilitating fear of physical movement and activity resulting from a feeling of vulnerability and susceptibility to painful injury or re-injury [23]. Kinesiophobia is one potential underlying reason why many people do not return to sports after ACL reconstruction [11,12,24].

Examining psychological factors before and after rehabilitation and understanding which psychological impairments contribute most significantly to function following knee surgery will assist in establishing appropriate rehabilitation programs in this patient population. The objectives of this study were (1) to measure pain catastrophizing and kinesiophobia levels and (2) determine their association with self-reported subjective knee function during rehabilitation following anterior cruciate ligament reconstruction and meniscectomy.

2. Materials and methods

2.1. Sample

This study included 41 participants, 22 following anterior cruciate ligament reconstruction and 19 meniscectomy, who were receiving rehabilitation in the Department of Rehabilitation, Hospital of Lithuanian University of Health Sciences. Rehabilitation was not controlled in this study. Pain catastrophizing and kinesiophobia were not formally addressed during rehabilitation. This was done in order to observe changes in pain catastrophizing and kinesiophobia beliefs during rehabilitation without specific treatment focused on modifying these fear-avoidance beliefs.

The inclusion criteria were as follows: (1) age between 25 and 50 years, (2) unilateral anterior cruciate ligament rupture combined with or without associated meniscus injury, and isolated meniscus injury, (3) asymptomatic contralateral knee, (4) completion of a rehabilitation program, (5) completed pre- and post-assessment. The exclusion criteria were (1) previous anterior cruciate ligament and meniscus injury and/or surgery, (2) bilateral knee injury, (3) collateral ligament and posterior cruciate ligament injuries, (4) participation in other studies.

2.2. Measures

Demographic and clinical information were collected. These variables included age (years), sex, time between injury and surgery (months), time between surgery and rehabilitation (days), previous knee injuries or surgeries, concomitant injuries, physical activity level before injury (well-trained and frequently sporting, sporting sometimes, non-sporting).

Knee pain intensity was measured with an 11-point Numeric Pain Rating Scale (NRS) [25]. Pain intensity ratings range from 0 as ‘‘no pain’’ and 10 as ‘‘the worst imaginable pain.’’ A higher score indicates greater pain intensity. The

current (pain intensity level during examination) and the worst (the highest pain intensity level over the last 24 h) pain intensity level was measured. In a sample of patients with shoulder and neck pain, test-retest reliability (intraclass correlation coefficient) for the NRS was reported to be 0.74 and 0.76 and the minimum detectable change was reported to be 2.5 and 2.1 points [26,27]. To our knowledge, reliability of this measure has not been assessed in patients with ACLR and meniscectomy.

Pain catastrophizing was assessed with the Pain Catastrophizing Scale (PCS). The PCS is a self-report questionnaire, which asks participants to indicate the frequency with which they experience different thoughts related to their pain experience [28]. The PCS includes 13 items, which relate to rumination (e.g. ''When I'm in pain, I can't seem to keep it out of my mind''), magnification (e.g. ''When I'm in pain, I become afraid that the pain will get worse''), and helplessness (e.g. ''When I'm in pain, it's terrible and I think it's never going to get any better''). Each item on the questionnaire is scored from 0 (''not at all'') to 4 (''all the time'') [29]. The item scores are summed to create a total score that ranges from 0 to 52 points, with higher scores indicating higher levels of pain catastrophizing [28,30]. In a sample of patients with chronic low back pain, test-retest reliability (intraclass correlation coefficient) for the PCS has been reported to be 0.93 and the minimal detectable change is 9 points [31].

Kinesiophobia was assessed with the shortened version of the Tampa Scale of Kinesiophobia (TSK-11). TSK-11 is an 11-item questionnaire that eliminates psychometrically poor items from the original version of the TSK to create a shorter questionnaire with comparable internal consistency [32,33]. The TSK-11 includes 11 items, which relate to somatic sensations (e.g., ''Pain always means I have injured my body'') or activity avoidance (e.g., ''I cannot do all the things normal people do because it is too easy to get injured''). Each item on the questionnaire is scored from 1 (''strongly disagree'') to 4 (''strongly agree''). The item scores are summed to create a total score that ranges from 11 to 44 points, and higher scores indicate greater pain-related kinesiophobia [34]. The Tampa Scale of Kinesiophobia, an instrument originally designed for patients with low back pain [33]. In a sample of patients with low back pain, test-retest coefficients (intraclass correlation coefficient) for the TSK-11 range from 0.81 to 0.93 and the minimal detectable change in level of kinesiophobia is 4 points [32,33]. The reliability of the TSK-11 questionnaire has not been assessed in patients with ACLR and meniscectomy.

The subjective knee function was assessed with the Knee Injury and Osteoarthritis Outcome Score (KOOS), which determines the patients' opinion about their knee function and associated problems [35]. The KOOS consists of five subscales: pain, other symptoms, function in daily living, function in sport and recreation, and knee-related quality of life [36]. A score is calculated within every subscale, where 100 represents ''no problems'' and 0 represents ''extreme problems'' related to knee function. In our study we used 3 subscales: pain subscale assesses the amount of knee pain that individuals experience during daily activities; function in daily living subscale assesses the difficulties that individuals may experience during activities of daily living; knee-related quality of life subscale assesses the quality of life, mental and social aspects such as awareness and lifestyle changes. The KOOS has been demonstrated to contain items regarding symptoms and disabilities, important to patients with an ACL tear and isolated meniscal tears [37]. In a sample of patients with knee injuries, test-retest coefficients (intraclass correlation coefficient) for KOOS Pain subscale range from 0.85 to 0.95, KOOS Function in daily living subscale from 0.75 to 0.91 and KOOS Knee-related quality of life subscale from 0.83 to 0.95 [36].

2.3. *Design/procedure*

This was a pilot study that assessed the association of pain catastrophizing and kinesiophobia with self-reported subjective knee function during rehabilitation following anterior cruciate ligament reconstruction and meniscectomy. The study was conducted between October 2013 and April 2014. Data collection was performed by semi-structured interviews, conducted by one physiotherapist who was not involved in the participants' rehabilitation. The data were collected two times: before rehabilitation (1st or 2nd day of rehabilitation) and after rehabilitation (the last day of rehabilitation). Participants were asked to provide demographic information and to complete a paper copies of the self-report questionnaires of pain catastrophizing (PCS), kinesiophobia (TSK-11), subjective knee function (KOOS pain, activities of daily living, knee-related quality of life) and knee pain intensity (NRS).

All participants were given a standard rehabilitation program within 14 days. During rehabilitation participants underwent 7 water-based and 7 land-based physiotherapy exercise procedures (once a day, 5 times a week). The rehabilitation program also included modalities for pain management.

This study was approved by the Bioethics Centre of the Lithuanian University of Health Sciences. The participants were informed about the research and informed consent to study participation was requested. Confidentiality, anonymity and the participant's rights were emphasized.

2.4. *Statistical analysis*

Statistical analysis was conducted using ''SPSS Campus Professional Desktop''. Descriptive statistics, including mean and standard deviation (SD) were calculated for continuous variables (age, time between injury and surgery, time between surgery and rehabilitation, level of the pain catastrophizing, kinesiophobia and pain intensity). For categorical variables (sex, concomitant injuries, physical activity level), percentages (%) and absolute (n) frequencies were presented.

The Wilcoxon test for paired groups was used to evaluate the PCS and TSK-11 scores differences before and after rehabilitation. The Mann–Whitney U test was used to evaluate the PCS, TSK-11 and NRS scores differences between participants after ACLR and meniscectomy. A P value of less than 0.05 was considered to be statistically significant.

Spearman rank correlation was used to assess correlations between the results of TSK-11, PCS and KOOS subscales (pain, function in daily living, knee-related quality of life) results. The strength of the correlations was interpreted based on the following criteria: no relationship ($0.00 < r < 0.25$ or

$-0.25 < r < 0.00$), weak relationship ($0.25 < r < 0.50$ or $-0.50 < r < -0.25$), moderate relationship ($0.50 < r < 0.75$; $-0.75 < r < -0.50$), and strong relationship ($0.75 < r < 1.00$ or $-1.00 < r < -0.75$). Statistical significance was set at $P < 0.05$.

3. Results

All the participants who met the study inclusion criteria and were enrolled in the study completed the study. Table 1 presents the demographic characteristics of the total sample and separately of participants after ACLR and meniscectomy. The mean age of the participants after ACLR and meniscectomy was 35 (SD, 1.7) years and 46 (SD, 1.7) years, respectively. The participants after ACLR on average were 10 years younger ($P < 0.05$). Before injury, 11 (27%) participants were well-trained and frequently active in sports such as football, basketball, tennis.

The mean PCS score before rehabilitation was 5.8 (SD, 0.9; range, 1–20), after rehabilitation – 4.2 (SD, 0.5; range 0–17). The PCS scores statistically decreased over rehabilitation ($P < 0.05$), this means that pain catastrophizing level after rehabilitation was less than before rehabilitation. The range of the PCS scores change was from 1 to 6 points. The mean TSK-11 score before rehabilitation was 22.7 (SD, 0.7; range, 13–32) and after rehabilitation, 18.4 (SD, 0.6; range, 12–27). The TSK-11 scores statistically decreased during rehabilitation ($P < 0.05$), which means that participants experienced less kinesiophobia after rehabilitation. The range of the TSK-11 scores change was from 1 to 8 points. The mean level of current pain before rehabilitation was 4 (SD, 0.2; range, 1–6) and after rehabilitation, 1 (SD, 0.1; range, 0–3) point. In addition, the mean level of the worst pain before rehabilitation was 6 (SD, 5.9; range, 2–8), after rehabilitation – 2 (SD, 0.1; range, 0–4) points. In Table 2 are represented descriptive statistics for PCS, TSK-11, NRS results, calculated separately for participants after ACLR and meniscectomy. Comparing PCS, TSK-11, NRS results between participants after ACLR and meniscectomy no statistically significant differences were found before and after rehabilitation ($P > 0.05$).

Correlations were calculated between PCS, TSK-11 and KOSS subscales (pain, function in daily living, knee-related quality of life) for all participants. The correlation between PCS and KOOS subscales before and after rehabilitation are represented in Table 3. There was a moderate negative correlation between the PCS and the KOOS Pain ($r = -0.558$, $P = 0.000$; $r = -0.569$, $P = 0.000$), function in daily living ($r = -0.598$, $P = 0.000$; $r = -0.569$, $P = 0.000$), knee-related quality of life ($r = -0.603$, $P = 0.000$; $r = -0.582$, $P = 0.000$) subscales before and after rehabilitation. A higher PCS score correlated

Table 1 – Demographic information of all participants and participants after anterior cruciate ligament reconstruction and meniscectomy.

Variable	All participants ($n = 41$)	Participants after ACLR ($n = 22$)	Participants after meniscectomy ($n = 19$)
Age, mean (SD), years	40 (1.4)	34.9 (1.7)	45.5 (1.7)
Sex, *n* (%)			
Male	29 (71)	17 (77)	12 (63)
Female	12 (29)	5 (23)	7 (37)
Time between injury and surgery, mean (SD), months	5.2 (0.8)	3.6 (1.1)	7.2 (1.1)
Time between surgery and rehabilitation, mean (SD), days	28.4 (0.6)	28.3 (0.7)	28.4 (1.1)
Concomitant injuries, *n* (%)			
Isolated ACL tear	–	9 (41)	–
ACL tear with meniscal repair	–	13 (59)	–
Physical activity level, *n* (%)			
Well-trained and frequently sporting	11 (27)	8 (36)	3 (16)
Sporting sometimes	10 (24)	7 (32)	3 (16)
Non-sporting	20 (49)	7 (32)	13 (68)

ACLR, anterior cruciate ligament reconstruction;
ACL, anterior cruciate ligament

Table 2 – Descriptive statistics for PCS, TSK-11, NRS results for participants after ACLR and meniscectomy.

	Participants after ACLR	Participants after meniscectomy
$PCS_{before\ rehabilitation}$	5.2 (0.9) [1–20]	6.5 (1.0) [0–14]
$PCS_{after\ rehabilitation}$	3.8 (0.8) [0–17]	4.7 (0.6) [0–9]
$TSK\text{-}11_{before\ rehabilitation}$	22.5 (0.9) [13–29]	23.1 (1.0) [15–32]
$TSK\text{-}11_{after\ rehabilitation}$	18.2 (0.7) [12–24]	18.7 (0.9) [12–27]
NRS Current $pain_{before\ rehabilitation}$	4.5 (0.2) [3–6]	4.0 (0.3) [1–6]
NRS Current $pain_{after\ rehabilitation}$	1.1 (0.2) [0–2]	1.3 (0.2) [0–3]
NRS Highest $pain_{before\ rehabilitation}$	6.3 (0.2) [5–8]	1.9 (0.2) [1–7]
NRS Highest $pain_{after\ rehabilitation}$	5.5 (0.3) [1–4]	1.7 (0.2) [1–4]

Values are mean (standard deviation) [range].
PCS, Pain Catastrophizing Scale; TSK-11, shortened version of the Tampa Scale of Kinesiophobia; NRS, numeric pain rating scale; ACLR, anterior cruciate ligament reconstruction.

Table 3 – Correlation between PCS and KOOS pain, KOOS function in daily living, KOOS knee-related quality of life subscale scores before and after rehabilitation.

	PCS before rehabilitation	PCS after rehabilitation	PCS change score
Pain subscale before rehabilitation	−0.558**	−0.525**	0.439**
Pain subscale after rehabilitation	−0.605**	−0.569**	0.514**
Pain subscale change score	−0.367*	−0.351*	0.125
Function subscale before rehabilitation	−0.598**	−0.573**	0.521**
Function subscale after rehabilitation	−0.519**	−0.569**	0.410**
Function subscale change score	−0.565**	−0.358*	0.466**
Quality of life subscale before rehabilitation	−0.603**	−0.554**	0.471**
Quality of life subscale after rehabilitation	−0.575**	−0.582**	0.281
Quality of life subscale change score	−0.060	−0.060	0.266

Spearman rank correlation coefficients (r_s) are presented.
* Correlation is significant at the $P < 0.05$ level.
** Correlation is significant at the $P < 0.01$ level.
PCS, Pain Catastrophizing Scale; KOOS, Knee Injury and Osteoarthritis Outcome Score.

with a higher level of knee pain during activities, with more difficulties experienced during daily activities and with poorer knee-related quality of life. No correlation was found between changes in PCS scores and changes in the KOOS Pain ($r = 0.125$, $P = 0.435$), and knee-related quality of life ($r = 0.266$, $P = 0.092$) subscales scores. A weak correlation was found between the changes in PCS scores and the changes in the KOOS function in daily living ($r = 0.466$, $P = 0.002$) subscale scores.

The correlation between TSK-11 and KOOS subscales before and after rehabilitation are represented in Table 4. A weak negative correlation was found between the TSK-11 score and the KOOS Pain ($r = -0.456$, $P = 0.003$; $r = -0.433$, $P = 0.005$) subscale before and after rehabilitation. In addition, there was a moderate negative correlation between the TSK-11 score and the KOOS Function in daily living ($r = -0.461$, $P = 0.002$; $r = -0.538$, $P = 0.000$) subscale score before and after rehabilitation, as well as the TSK-11 score and the KOOS Knee-related quality of life ($r = -0.560$, $P = 0.000$) subscale score before rehabilitation. A high kinesiophobia level was correlated with more difficulties experienced in daily activities and poorer knee-related quality of life. No correlation was found between the changes in the TSK-11 scores and the changes in the function in daily living ($r = 0.038$, $P = 0.815$), and knee-related quality of life ($r = 0.069$, $P = 0.667$) subscales scores. A weak correlation was found between the changes in TSK-11 scores and the changes in the KOOS pain ($r = 0.407$, $P = 0.008$) subscale scores.

4. Discussion

The objectives of this study were (1) to measure pain catastrophizing and kinesiophobia levels and (2) determine their association with self-reported subjective knee function during rehabilitation following anterior cruciate ligament reconstruction and meniscectomy.

The influence of the pain catastrophizing and kinesiophobia on knee function can be explained by the fear-avoidance model, which has an important role in patient behavior [18]. Among patients with fewer fear-avoidance beliefs, fear usually dissipates as the musculoskeletal condition resolves. Those patients interpret pain as non-threatening and are likely to maintain their activities of daily living despite pain as a result of this is facilitated recovery. When patients experience a recurrent painful stimulus, an exaggerated negative psychological response to pain or the anticipation of pain (pain catastrophizing) leads to an active avoidance of movement out of fear of recurrent pain or injury (kinesiophobia) [18].

Table 4 – Correlation between TSK-11 and KOOS pain, KOOS function in daily living, KOOS knee-related quality of life subscale scores before and after rehabilitation.

	TSK-11 before rehabilitation	TSK-11 after rehabilitation	TSK-11 change score
Pain subscale before rehabilitation	−0.456**	−0.310*	0.436**
Pain subscale after rehabilitation	−0.507**	−0.433**	0.332*
Pain subscale change score	−0.24	−0.06	0.407**
Function subscale before rehabilitation	−0.461**	−0.463**	0.178
Function subscale after rehabilitation	−0.578**	−0.538**	0.298
Function subscale change score	−0.250	−0.290	0.038
Quality of life subscale before rehabilitation	−0.560**	−0.494**	0.337*
Quality of life subscale after rehabilitation	−0.420**	−0.310	0.369*
Quality of life subscale change score	−0.20	−0.280	0.069

Spearman rank correlation coefficients (r_s) are presented.
* Correlation is significant at the $P < 0.05$ level.
** Correlation is significant at the $P < 0.01$ level.
TSK-11, shortened version of the Tampa Scale of Kinesiophobia; KOOS, Knee Injury and Osteoarthritis Outcome Score.

Although avoidance behaviors may be adaptive in the context of acute pain by allowing an acute injury to heal. However, long-term avoidance of physical activity is thought to impair daily functioning and can have negative effect on rehabilitation outcomes [38]. These elevated fear-avoidance beliefs can be maladaptive, leading to chronic pain, increased pain sensitivity, psychological distress, disuse and reduced function [11,12,38]. George et al. [32] noted that in the early postoperative phase, activity and exercises are modified to allow tissue healing. Chance of injury or re-injury is quite low and there is potential that the excessive fear of injury is a modifiable factor that may allow earlier achievement of pain relief and function recovery. According to the Fear-avoidance model, patients with elevated pain catastrophizing and kinesiophobia are hypervigilant toward painful stimuli, paying less attention to the other tasks [39]. Hypervigilance and avoidance of physical activity can have negative influence on rehabilitation process and recovery duration [40]. Because patient avoids movement and activity so as to not provoke pain and this in turn leads to disengagement from meaningful exercises and activities during rehabilitation.

In our study population, TSK-11 scores were lower compared to those TSK-11 scores reported for other musculoskeletal conditions, namely in work-related upper extremity disorders (a score of 25.6), chronic low back pain (a score of 27.7), osteoarthritis (a score of 24.5 points), and various chronic musculoskeletal pain conditions (a score of 28.5) [41]. However, comparing TSK-11 scores between different musculoskeletal pain conditions should be considered pain duration and intensity, disease category, injury mechanism, patterns of improvement in pain intensity and function, prognosis of recovery and rehabilitation professionals' attitudes toward different medical conditions. Rehabilitation professionals' attitudes toward the severity of musculoskeletal condition and duration of recovery can have effect on patient fear-avoidance beliefs [42]. For example, among patients with not severe musculoskeletal injuries, a rehabilitation professional may be confident of recovery in a short duration of time and may convey a reassuring message to the patient [42]. When patients view their condition as temporary, this can cause that patients experience less fear of pain related to activity. This may result in a more confrontational response to the pain and better functional recovery [43]. In contrast, with more severe musculoskeletal injuries, a rehabilitation professional may convey that rehabilitation may not be successful, and the patient may eventually need for additional treatments (e.g., surgery) if the symptoms persist. These expectations of more delayed recovery may support the maintenance of fear-avoidance beliefs, which can cause delayed recovery.

Our TSK-11 and PCS results are close to those recorded in other studies. When these results are compared, the difference in time between surgery and assessment must be taken into account. Chmielewski et al. [34] reported that the mean PCS score was 5.6 (SD, 7.7), TSK-11 score – 20.8 (SD, 6.0) at the 4-week time point (the mean number of days after surgery, 30.4; SD, 5.4). The mean PCS score was 5.3 (SD, 8.5) and the mean TSK-11 score was 19.5 (SD, 5.9) at the 8-week time point (the mean number of days after surgery, 59.6; SD, 6.2). In addition, the mean PCS score and the mean TSK-11 score were 4.0 (SD, 7.3) and 17.9 (SD, 5.9), respectively, at the 12-week time point (the mean number of days after surgery, 88.9; SD, 10.2). These scores suggest that during the 12 weeks after ACL reconstruction, the psychosocial factors (such as pain catastrophizing, kinesiophobia and self-efficacy) are modified in a favorable manner; interventions aimed at increasing self-efficacy for rehabilitation tasks or decreasing kinesiophobia have the potential to improve short-term outcomes for knee pain and function [34]. In other study, in the early postoperative phase, where mean duration from surgery was 54.7 (SD, 24.5) days, the mean TSK-11 score was 20.0 (SD, 6.3) and mean PCS was 5.4 (SD, 8.1) points [35]. In the late postoperative phase, where mean duration from surgery was 254.5 (SD, 97.2), the mean TSK-11 was 18.0 (SD, 5.4), the mean PCS was 3.6 (SD, 5.7). When analyzing these results it should be noted that the study was limited by its recruitment of separate groups of patients for a convenience sample at each postoperative period [35]. All these study results show that the kinesiophobia decrease over time after surgery, but one study found that after 3–4 years the patients still experience some fear of movement [11]. On the other hand, some researchers suggest that the change in the TSK-11 scores that occurs over time may not be linear in nature [43].

The PCS and TSK-11 scores statistically decreased over rehabilitation ($P < 0.05$). Although, approximately 34% of all participants did not achieve the minimal clinically important change of 4 points in kinesiophobia, which has been determined in people with chronic low back pain [31]. No one of participants achieved the minimal clinically meaningful improvement for PCS (9 points) during rehabilitation, which also has been determined in people with chronic low back pain [31]. It should be taken into account that minimal clinically important change was calculated for people with chronic low back pain. The future research should determine the minimal clinically important change for patients after ACLR or meniscectomy. Because these results can differ due to the fact that patients with low back pain experience greater and chronic pain. As a consequence patients with greater pain catastrophizing and kinesiophobia could require a greater change in PCS and TSK-11 scores to achieve clinically important decrease in scores.

Chmielewski et al. [12] assessed the fear of movement/re-injury levels and determined the association with function during ACLR rehabilitation. They determined that, while fear of movement/re-injury levels appears to decrease during ACLR rehabilitation, these factors were still associated with function in the timeframe when patients return to sport. In other study, the TSK and the KOOS questionnaires were used to investigate whether fear of re-injury due to movement is of significance for returning to previous level of activity in patients 3 to 4 years following ACL reconstruction [11]. The results of this study show that approximately 53% of the patients had returned to their pre-injury activity level [11]. Many patients complained that their performance was worse at the follow-up compared to before the injury and 24% of them reported that the cause was fear of re-injury [11]. Also they suggests that a greater focus on the psychological aspects of the injury during the rehabilitation may help the injured athletes to return to their previous level of activity [11]. This is because psychological recovery and physical

recovery do not occur simultaneously [24]. However, it is very important to not only evaluate the influence of psychological variables on the athletes' population, but also involve the sedentary population in these studies and evaluate the influence of these variables on returning to work and participation in daily living activities.

George et al. [32] also highlighted that a physiotherapist should identify people with a continued high kinesiophobia level and then address it. Many studies emphasize that psychological responses to the initial injury, to surgery, to recovery and rehabilitation might be an important additional determinant of reintegration into usual activities and returning to sport after surgery [24,44]. Methods which assess kinesiophobia or re-injury can be implemented in patient assessment in conjunction with physical assessment before rehabilitation. This can help to identify those at risk of developing potentially maladaptive psychological responses to injury, and implement strategies to address these issues. But there are a lot of questions which should be addressed in future research. Further studies are needed to provide guidelines for interpreting the clinical meaning of pain catastrophizing and kinesiophobia scores before and after treatment in this population. Because fear-avoidance beliefs can be an important predictor of functional outcomes for some patients but not for others. Using of diagnostic categories may allow physiotherapists to identify subgroups of patients who need the treatment for negative fear-avoidance beliefs. Also a better understanding of factors that influence pain catastrophizing and kinesiophobia levels is needed, so that interventions can be targeted to individuals who will benefit the most.

Interpretation of the present study findings must be made with caution and these findings are probably most useful for providing impetus for future research. First, the study population was not homogeneous. The study sample consisted not only of individuals following anterior cruciate ligament reconstruction, but also of the ones following meniscectomy. The small sample size might also limit the generalization of the findings. Second, only self-report measures of knee function were used. Whereas function assessment with self-report questionnaires and performance-based tests can produce different conclusions. Third, we used validated psychological questionnaires whose psychometric properties have not been tested in patients with ACL reconstruction and meniscectomy yet. Other issues should be taken into account when interpreting findings are time after surgery and length of the rehabilitation because time can affect the results.

Despite these limitations, the current study may provide new insights into investigation of the pain catastrophizing and kinesiophobia influence on knee function during rehabilitation following ACLR and meniscectomy. Studies tend to involve people who are active in sports, but the findings of these studies may not extend to a more sedentary population [11,43,45]. In our study, we want to encourage the scientific community to evaluate the potential role of psychological factors in rehabilitation after knee surgery in the non-sporting population. In addition studies tend to include only patients with primary ACL reconstruction, without concomitant ligament injuries or articular cartilage damage requiring repair, but these results may not be applied universally to all patients following ACL reconstruction [12,34,43,45,46].

Although, additional injuries may influence functional outcomes, a high incidence of concomitant injuries indicate that studies should involve patients with multiple injuries. This study included patients with primary ACL reconstruction, with concomitant meniscus injuries. The present study design includes a follow-up evaluation after initial participants' assessment that gives opportunity to evaluate improvement.

The findings of the present and previous studies [11,12,34,43] may facilitate continued investigation directed at understanding the integration of the psychological factors such as catastrophizing and kinesiophobia in rehabilitation after ACLR and meniscectomy. Future research should examine the influence of other psychological variables (i.e., self-efficacy, confidence in knee function, motivation and expectations). Also, information about mechanism of injury (''contact'' or ''non-contact''), injury situation (''sports'' or ''non-sports''), and graft type ''allograft'' or ''autograft'' should be collected and influence of these variables on psychosocial factors should be assessed.

5. Conclusions

Pain catastrophizing and kinesiophobia decreased significantly during rehabilitation. A higher level of pain catastrophizing was significantly correlated with a greater level of knee pain during activities, more difficulties experienced during daily activities before and after rehabilitation. A high level of kinesiophobia was significantly correlated with more difficulties experienced in daily activities and poorer knee-related quality of life before and after rehabilitation.

Ethics

The experiments comply with the current Lithuanian laws. This study was approved by the Bioethics Centre of the Lithuanian University of Health Sciences. The participants were informed about the research and informed consent to study participation was requested. Confidentiality, anonymity and the participant's rights were emphasized. All the patients gave written informed consent.

The manuscript does not concern any commercial product. All the authors have reviewed and approved the manuscript before submission.

Conflict of interest

The authors state no conflict of interest.

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