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Kinesiophobia After Anterior Cruciate Ligament Rupture and Reconstruction: Noncopers Versus Potential Copers

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Abstract

STUDY DESIGN—Secondary-analysis, longitudinal cohort study.

OBJECTIVES—To compare kinesiophobia levels in noncopers and potential copers at time points spanning pre- and post-anterior cruciate ligament (ACL) reconstruction and to examine the association between changes in kinesiophobia levels and clinical measures.

BACKGROUND—After ACL injury, a screening examination may be used to classify patients as potential copers or noncopers based on dynamic knee stability. Quadriceps strength, single-leg hop performance, and self-reported knee function are worse in noncopers. High kinesiophobia levels after ACL reconstruction are associated with poorer self-reported knee function and lower return-to-sport rates. Kinesiophobia levels have not been examined before ACL reconstruction, across the transition from presurgery to postsurgery, or based on potential copers and noncoper classification.

METHODS—Quadriceps strength indexes, single-leg hop score indexes, self-reported knee function (Knee Outcome Survey activities of daily living subscale, global rating scale), and kinesiophobia (Tampa Scale of Kinesiophobia [TSK-11]) scores were compiled for potential copers ($n = 50$) and noncopers ($n = 61$) from 2 clinical trial databases. A repeated-measures analysis of variance was used to compare TSK-11 scores between groups and across 4 time points (before preoperative treatment, after preoperative treatment, 6 months post-ACL reconstruction, and 12 months post-ACL reconstruction). Correlations determined the association of kinesiophobia levels with other clinical measures.

RESULTS—Presurgery TSK-11 scores were significantly higher in noncopers than in potential copers. Postsurgery, no group differences existed. TSK-11 scores in both groups decreased across

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all time points; however, TSK-11 scores decreased more in noncopers in the interval between presurgery and postsurgery. In noncopers, the decreases in TSK-11 scores from presurgery to postsurgery and after surgery were related to improvements in the Knee Outcome Survey activities of daily living subscale, whereas the association was only present in potential copers after surgery.

CONCLUSION—Kinesiophobia levels were high in both noncopers and potential copers preoperatively. Restoration of mechanical knee stability with surgery might have contributed to decreased kinesiophobia levels in noncopers. Kinesiophobia is related to knee function after surgery, regardless of preoperative classification as a potential coper or noncoper.

Keywords

ACL; fear; functional outcomes; knee; rehabilitation; Tampa Scale of Kinesiophobia-11

Anterior cruciate ligament (ACL) rupture is common in athletes and usually prohibits sports participation.^{6,52,53} ACL reconstruction surgery is the standard of care in the United States.³⁷ The surgery is performed to stabilize the knee joint to prevent further injuries and to allow the patient to return to previous levels of activity. However, many people do not return to sport after ACL reconstruction,^{3–5,24} and kinesiophobia (eg, fear of movement/reinjury) is one potential underlying reason.^{5,12,29} Up to 24% of patients with ACL reconstruction do not return to sport because of fear of reinjury.^{10,29,31} Kinesiophobia levels have been objectively quantified with the Tampa Scale of Kinesiophobia (TSK-11).⁵⁴ Based on TSK-11 scores, kinesiophobia levels generally decrease through the early and advanced phases of ACL reconstruction rehabilitation,¹² but higher TSK-11 scores are associated with worse self-reported knee function and a lower return-to-sport rate.^{29,33} Thus, kinesiophobia is an important psychosocial construct in ACL rehabilitation.

Following ACL injury, there is a differential response among patients in dynamic knee stability and knee function (self-reported and performance based), with some people faring better than others.^{18,19} A screening examination was developed to distinguish individuals soon after ACL injury, based on the potential to dynamically stabilize the knee during high-demand activities.¹⁹ Those who do not pass the screening examination (classified as noncopers) are considered to be less able to dynamically stabilize the knee and are recommended for ACL reconstruction. In contrast, those who do pass the screening examination (classified as potential copers) are considered to be potentially able to dynamically stabilize the knee in the short term and are allowed to attempt high-demand activities following a specialized nonoperative rehabilitation program.¹⁹ The classifications of noncoper and potential coper are not based on the psychosocial phenomenon of coping with the injury. Potential copers demonstrate the functional requirements with their existing level of knee function, as defined by the screening examination that includes 4 specific cutoff criteria, whereas noncopers are unable to meet each of the 4 specific cutoff criteria (TABLE 1).¹⁹ In addition to experiencing more episodes of the knee giving way and poorer performance-based and self-reported knee function,^{19,32} noncopers demonstrate more asymmetries between limbs in their movement patterns.^{45,46} An inability to dynamically stabilize the knee soon after injury could lead to higher levels of kinesiophobia in noncopers.

A neuromuscular training program that includes the application of perturbations to the lower extremity²¹ has been developed and used in the preoperative rehabilitation of both potential copers and noncopers.^{20,23,24} Potential copers treated with neuromuscular training have demonstrated superior return-to-sport outcomes compared to those who participated in traditional rehabilitation.²⁰ A neuromuscular training program has been shown to improve indicators of dynamic knee stability, such as decreasing muscle cocontraction and improving knee kinematics, for both potential copers and noncopers.^{20,38} It is unknown whether a neuromuscular training program helps to reduce kinesiophobia or whether reduced kinesiophobia is related to improvements in clinical measures (eg, quadriceps strength, hop tests, and self-reported knee function). Because noncopers have poorer dynamic knee stability acutely after injury, this group has the potential to obtain greater improvements in clinical measures. For this reason, noncopers may show greater reductions in kinesiophobia after a neuromuscular training program than potential copers. In addition, surgical reconstruction restores mechanical stability of the knee and may lead to reduced kinesiophobia levels. To date, no study has examined changes in kinesiophobia levels after ACL injury in response to neuromuscular training that includes perturbation training or ACL reconstruction, both of which aim to eliminate instability in the knee.

The purpose of this study was to compare kinesiophobia levels between noncopers and potential copers across periods spanning pre- and post-ACL reconstruction and to examine the association between changes in kinesiophobia levels, quadriceps strength, and self-reported and performance-based knee function. We hypothesized that noncopers would have higher levels of kinesiophobia before, but not after, ACL reconstruction. We also hypothesized that kinesiophobia would decrease over time in both groups, specifically, after (1) a period of preoperative rehabilitation that included a neuromuscular training program known to improve dynamic stability, (2) ACL reconstruction, and (3) a period of 6 to 12 months post-ACL reconstruction. Finally, we hypothesized that changes in kinesiophobia would correlate with changes in quadriceps strength and self-reported and performance-based knee function. Examining kinesiophobia in potential copers and noncopers can increase knowledge about this psychosocial construct after ACL injury, particularly in reference to dynamic knee stability. In addition, examining kinesiophobia before and after a preoperative neuromuscular training program and ACL reconstruction would provide information about the potential for the interventions to influence this psychosocial construct.

METHODS

Patients

This is a secondary analysis of data from 2 longitudinal clinical studies involving patients with ACL injury. Patients were eligible for this study if they (1) were between 13 and 55 years of age, (2) had a unilateral ACL rupture confirmed with magnetic resonance imaging¹⁷ and at least a 3-mm side-to-side difference in anterior knee laxity determined with a knee arthrometer (KT1000; MEDmetric Corporation, San Diego, CA),⁵⁵ (3) regularly participated (more than 50 hours per year) in level 1 and 2 sports (jumping, cutting, pivoting, and lateral movements)²⁵ prior to surgery and desired to return to a level 1 or 2 sport, (4) underwent ACL reconstruction, and (5) had TSK-11 scores collected from at least 1 data-collection

time point. Patients with any of the following were excluded from the study: bilateral injury, concomitant injury (eg, other ligamentous injury of grade 3, full-thickness chondral defect of greater than 1 cm²), concomitant surgery that required a modified rehabilitation protocol (eg, meniscal repair or articular cartilage microfracture), pregnancy, or previous knee surgery. Approval for the 2 parent studies was granted by the University of Delaware Institutional Review Board, rights of the patients were protected, and all patients gave written informed consent. Patients who were minors gave assent to participate in the study, and informed consent was obtained from a parent or guardian.

Testing Overview

Data were collected at 4 time points: the time of the screening examination (before preoperative treatment), after a preoperative neuromuscular training program (after preoperative treatment), 6 months after ACL reconstruction, and 12 months after ACL reconstruction. Demographic data collected during the screening examination included the patient's age, time from the injury to the screening examination, height, weight, and sex. At all 4 time points, data were collected for a quadriceps strength index, 4 single-leg hop tests, self-reported questionnaires rating daily knee function (Knee Outcome Survey activities of daily living subscale [KOS-ADL]), global knee function (global rating scale [GRS]), and kinesiophobia levels (TSK-11).

Screening Examination—Prior to undergoing the screening examination, each patient participated in a standardized physical therapy protocol that focused on minimizing knee impairments, including gait deviations, knee joint effusion, knee range-of-motion limitations, thigh muscle strength deficits (primarily quadriceps strength deficits), and knee pain. Screening was allowed when the patient demonstrated a knee effusion of less than 1+ (zero or trace),⁵⁰ full knee range of motion, no pain with vertical hopping on the injured leg, normal gait, and a quadriceps strength index of at least 70%.¹⁹

Quadriceps strength was measured with an electromechanical dynamometer (Kin-Com; Isokinetic International, Chattanooga, TN) during a maximum voluntary isometric contraction of the knee extensors in sitting.⁴⁹ Isometric testing is a reliable and accurate way to measure quadriceps strength.⁴⁸ 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.⁴⁹ Prescreening physical therapy continued until patients achieved a 70% quadriceps strength index, with testing every 2 to 3 weeks.¹⁹

The screening consisted of 4 single-leg hop tests, the KOS-ADL, GRS, and self-reported number of episodes of the knee giving way since the injury. All patients were required to wear an off-the-shelf functional knee brace during hop testing (DJO, LLC, Vista, CA). Multiple sizes of left and right knee braces were available, and physical therapists fit the patient with the appropriate knee brace. The 4 hop tests were the single hop, crossover hop, triple hop for distance, and 6-meter timed hop.³⁹ A symmetry index was computed for each hop test by dividing the hop distance on the injured limb by the hop distance on the uninjured limb, expressed as a percentage. Because lower numbers indicate better performance on the 6-meter timed hop test, the symmetry index for this test was calculated

as hop time on the uninjured limb divided by hop time on the injured limb, expressed as a percentage. Single-leg hop testing is a valid and reliable measure of functional performance.⁴³

After hop testing, patients completed the KOS-ADL and GRS, and reported the number of episodes of knee giving way since the injury. The self-reported questionnaires were administered after hop testing to allow patients to better estimate their functional status. The KOS-ADL includes 14 items, with lower scores representing greater knee symptoms and functional limitations during activities of daily living.²⁷ The GRS asks patients to rate their perceived level of knee function on a scale of 100 percentage points, with anchors of 0% (unable to perform any activity) and 100% (able to perform all preinjury activities, including sports, without limitation).²⁷ The KOS-ADL and GRS are valid and reliable for evaluating self-reported knee function,^{23,35} as well as for differentiating a noncoper from a potential coper.¹⁹

When screening was complete, the patients were classified as potential copers or noncopers, based on previously determined cutoff scores on 4 screening elements: number of episodes of knee giving way and scores on the 6-meter timed hop test, KOS-ADL, and GRS (TABLE 1).¹⁹ The cutoff scores reflect values that were 2 standard deviations below the group mean for patients who were unable to successfully return to sports after ACL rupture.¹⁹ If a patient failed to meet the established criteria on any of the 4 tests, the patient was classified as a noncoper, even if adequate scores were achieved on the other 3 tests. Patients who met the cutoff scores for all 4 tests were classified as potential copers. The data collections after the preoperative treatment, at 6 months post-ACL reconstruction, and at 12 months post-ACL reconstruction were conducted in the same manner, using the same testing protocol and order as the screening examination.

Tampa Scale of Kinesiophobia—The TSK-11 was added to the testing protocol approximately 1 year after recruitment for the 2 parent studies was initiated. The questionnaire was administered along with the other questionnaires in the screening protocol and was the last questionnaire to be completed in the packet. The TSK-11 was collected before and after the preoperative intervention, and 6 and 12 months post-ACL reconstruction. The TSK-11 includes 11 items, with scores ranging from 11 to 44 points, and higher scores indicating higher levels of kinesiophobia.¹⁵ Test-retest reliability, validity, responsiveness, and internal consistency have been assessed in patients with chronic low back pain, and psychometric properties are adequate and comparable to a longer version of the questionnaire.⁵⁴ A clinically meaningful change in the level of kinesiophobia has been determined to be a 4-point difference in TSK-11 scores.⁵⁴

Physical Therapy Overview

All patients received preoperative and postoperative physical therapy at the University of Delaware Physical Therapy Clinic, following practice guidelines.^{1,35} The physical therapy plan of care was individualized based on impairments, activity limitations, and participation restrictions. Treatment components, frequency, and duration were based on patient needs and the ability to meet established clinical milestones.^{1,35} Although rehabilitation sessions

were individualized to the patient's needs, the average session lasted approximately 1 hour. Kinesiophobia was not formally addressed during preoperative or postoperative rehabilitation, and no goals to reduce kinesiophobia were established.

Preoperative Neuromuscular Training Program—Patients typically received 10 preoperative physical therapy sessions (2 to 3 times per week for a 2- to 4-week period) that began after the screening examination and prior to undergoing ACL reconstruction. Specific goals after screening included unilateral strengthening to maximize quadriceps force output in the involved limb and neuromuscular rehabilitation, including perturbation training (described in detail elsewhere)²¹ to improve muscle reaction response time to specific directions and magnitudes of forces or perturbations to the limb's base of support. Preoperative goals were to minimize impairments, maximize quadriceps strength in the ACL-deficient limb, promote dynamic knee stability and symmetrical use of the lower extremities, and educate the patient on proper techniques with therapeutic exercises as part of the postoperative rehabilitation protocol.²⁴

ACL Reconstruction—All patients underwent an arthroscopic-assisted ACL reconstruction, performed by a single orthopaedic surgeon, using a quadrupled semitendinosus-gracilis (single-bundle) autograft or a soft tissue allograft.

Postoperative Rehabilitation—Goals after ACL reconstruction were to minimize impairments incurred during the surgical procedure by progressively achieving established postoperative clinical milestones.^{1,35} The criterion-based postoperative rehabilitation protocol included impairment resolution, progressive quadriceps strengthening, a high-intensity neuromuscular electrical stimulation protocol for quadriceps strengthening, and neuromuscular training to achieve progression through a walk/jog program and agility protocol. Perturbation training was not administered as part of the postoperative neuromuscular training protocol. Patients practiced low-level skills and progressed to more advanced sport-specific skills as milestones were reached. Treatment frequency varied, with greater frequency immediately after surgery and less frequency leading up to discharge. Most patients were discharged to independent programs by 6 months postsurgery, and returned only for testing sessions to acquire clinical measures until they passed all criteria deemed necessary to return to sports (eg, 90% or greater on all 7 components: quadriceps strength index, 4 single-leg hop tests, KOS-ADL, and GRS).¹

Data Analysis

Data were analyzed with SPSS Statistics 19 (IBM Corporation, Armonk, NY), and descriptive statistics were generated for demographic data, quadriceps strength, hop test scores, and KOS-ADL, GRS, and TSK-11 scores at all 4 time points. TSK-11 scores at the 4 testing time points were compared between noncopers and potential copers using 2 separate 2-way, mixed-model, repeated-measures analyses of variance (ANOVAs), with group as the between-patient variable and time as the within-patient variable. The first model was conducted only for those patients with a complete TSK-11 data set (ie, TSK-11 scores at all 4 testing time points). The second model was conducted with all patients in the study, including those with missing TSK-11 scores, consistent with an intention-to-treat analysis.

Regression imputation was used to estimate missing TSK-11 scores, regardless of where the missing data point existed. Specifically, a multiple-imputation method was chosen, as this method produces the most valid imputed values when approximately 30% of the data are missing.^{22,28,47} Multiple imputation involves mathematical linear equations, using the observed data to estimate missing data points. For example, the data observed before and after the preoperative treatment were used to calculate the predicted values that were missing after the preoperative treatment (FIGURE 1). In both ANOVA models, the interactions between group and time were first examined, and, if no interaction was present, group and time main effects were examined. If significant differences were observed, then post hoc pairwise comparisons were used to investigate differences.

Correlations were calculated between change in TSK-11 scores and change in the quadriceps strength index, 6-meter timed hop, KOS-ADL, and GRS for each group over 3 time intervals (from before to after the preoperative treatment, from after the preoperative treatment to 6 months post-ACL reconstruction, and from 6 months to 12 months post-ACL reconstruction). No values were imputed for missing data from the clinical measures (quadriceps strength values, 6-meter timed hop scores, KOS-ADL, or GRS). Therefore, if subjects had missing data for change scores in their clinical measures, those values were dropped from the correlation analysis. Reasons for missing data on clinical measures included the patient's quadriceps strength exceeding the limits of the Kin-Com, the patient not passing the clinical guidelines to complete the hop testing, or the patient not having data for 1 of the times needed to compute the change score. Parametric or nonparametric correlations were chosen based on classification of data types and statistical assumptions. The strength of the correlations was interpreted based on the following criteria: little or no relationship (0.00–0.25), fair relationship (0.25–0.50), moderate to good relationship (0.50–0.75), and good to excellent relationship (above 0.75).⁴² Statistical significance was set a priori at $P < .05$.

RESULTS

A total of 132 patients (79 noncopers, 53 potential copers) met the inclusion criteria for this study. Of these, 111 patients (61 noncopers, 50 potential copers) completed the TSK-11 questionnaire, and their data were analyzed further. Of 444 possible cells for TSK-11 scores (111 patients times 4 time points), 150 cells were missing data and 294 cells were filled with observed data, including 152 cells belonging to 38 patients (22 noncopers, 16 potential copers) with TSK-11 scores at all 4 time points. Each of the 150 missing values were replaced with predicted values from the multiple-imputation regression model.⁴⁰ Of the 73 patients with missing TSK-11 scores, 20 patients (11 noncopers, 9 potential copers) only had data for 1 time point, 37 patients (21 noncopers, 16 potential copers) had data for 2 time points, and 16 (7 noncopers, 9 potential copers) had data for 3 time points. Missing TSK-11 scores varied randomly over the 4 testing time points (FIGURE 2).

Demographic data for the 111 patients analyzed can be found in TABLE 2. TSK-11 scores for the patients with data available at all time points and for the entire sample are shown in TABLE 3. The result of the ANOVA model using 38 patients was similar to the ANOVA model using 111 patients; therefore, results for the model using the entire sample (ie,

intention-to-treat analysis) are reported. A time-by-group interaction ($P < .001$) was found. The source of the interaction occurred between the completion of the preoperative neuromuscular training program and 6 months post-ACL reconstruction, with TSK-11 scores improving more in noncopers than in potential copers (FIGURE 3). TSK-11 scores were significantly worse in noncopers than in potential copers before ($P = .011$) and after ($P = .022$) preoperative treatment, but no differences were found between groups at 6 ($P = .331$) and 12 months ($P = .667$) after ACL reconstruction (FIGURE 3). TSK-11 scores statistically decreased (less kinesiophobia) over time in both groups, from before to after preoperative treatment (noncopers, $P < .001$; potential copers, $P < .001$), after preoperative treatment to 6 months postoperative (noncopers, $P = .002$; potential copers, $P < .001$), and 6 to 12 months postoperative (noncopers, $P < .001$; potential copers, $P = .002$).

Descriptive statistics for quadriceps strength indexes, the 4 hop test indexes, and the 3 self-report questionnaires (KOS-ADL, GRS, TSK-11) were compiled for all 111 patients and reported for each group at the 4 time points (TABLE 4). Spearman rho correlations were used due to the nonparametric nature of our change scores. In the noncoper group, a statistically significant negative correlation was found between changes in TSK-11 scores and changes in the KOS-ADL after the preoperative treatment session to the 6-month postoperative session ($n = 46$, $r = -0.366$, $P = .012$). Also, a statistically significant negative correlation was found between changes in TSK-11 scores and changes in KOS-ADL scores from the 6- to 12-month postoperative sessions ($n = 47$, $r = -0.343$, $P = .018$) in the noncoper group. The magnitudes of these significant associations were fair, and the direction indicated that a decrease in kinesiophobia level was associated with an increase in knee function over the given times (from presurgery to postsurgery and from 6 to 12 months postsurgery, respectively). No other statistically significant correlations were found in the noncoper group.

In the potential coper group, statistically significant negative correlations were found between changes in the TSK-11 scores and changes in the KOS-ADL from the 6- to 12-month postoperative sessions ($n = 35$, $r = -0.422$, $P = .013$). The magnitude of the association was fair, and the direction indicated that a decrease in kinesiophobia level was associated with an increase in knee function from 6 to 12 months postsurgery. No other statistically significant correlations were found in the potential coper group.

DISCUSSION

This study compared kinesiophobia levels between individuals with ACL injury, classified as potential copers or noncopers, at specific time points from before to after ACL reconstruction. The relationship between changes in kinesiophobia levels (TSK-11 scores) and self-reported knee function (KOS-ADL, GRS), muscle performance (quadriceps strength index), and performance-based knee function (6-meter timed hop test) across time intervals was also examined in each group. We hypothesized that noncopers would have higher levels of kinesiophobia than potential copers preoperatively, and that no group differences would be present after ACL reconstruction. Our findings support this hypothesis and suggest that better knee stability (either dynamic or through surgical intervention) may

influence kinesiophobia levels, and that decreasing kinesiophobia levels are associated with improvements in self-reported knee function during daily activities (KOS-ADL).

Prior to surgery, both noncopers and potential copers were similar in that they were ACL deficient, but dynamic knee stability was worse in noncopers, based on clinical measures (number of episodes of the knee giving way, 6-meter timed hop test, KOS-ADL, GRS)^{20,26} and laboratory measures (movement patterns).^{11,13,14,23} Higher preoperative TSK-11 scores in noncopers compared to potential copers suggest that kinesiophobia levels are associated with the level of dynamic knee stability. To the best of our knowledge, this is the first study to report TSK-11 scores in athletes who are ACL deficient. The magnitude of TSK-11 scores in both groups (noncopers, 25.3 points; potential copers, 22.9 points) was similar to TSK-11 scores in people with chronic disorders such as work-related upper extremity disorders, chronic low back pain, fibromyalgia, and osteoarthritis.⁴⁴ Thus, kinesiophobia levels are high after ACL injury and need to be addressed during preoperative rehabilitation, specifically in people with poor dynamic knee stability.

Kinesiophobia levels were slightly reduced in both groups after participation in a preoperative neuromuscular training program. We expected that TSK-11 scores in noncopers would show more change after the preoperative intervention because they start at a lower level of dynamic knee stability. However, the change in TSK-11 scores from before to after the preoperative neuromuscular training program was not different between groups. In addition, the magnitude of change was less than 4 points, which has been determined to be the minimal clinically important difference in people with chronic low back pain.⁵⁴ Perturbation training has had positive effects on dynamic knee stability in noncopers and potential copers,²³ but the changes appear to be more subtle in noncopers.²⁰ Therefore, the neuromuscular intervention was only mildly successful at improving kinesiophobia levels. Others have reported successful outcomes after a longer bout of nonoperative rehabilitation in noncopers and potential copers³⁸; however, kinesiophobia levels were not reported. Noncopers and potential copers were able to successfully return to preinjury sports 12 months after ACL rupture, and group assignment did not dictate who returned to sports after nonsurgical management.³⁸ Because over 70% of noncopers demonstrate the functional ability to return to sports 12 months after surgery²⁴ or 12 months after ACL rupture,³⁸ noncopers, given the opportunity, may be able to demonstrate clinically meaningful reductions in kinesiophobia levels while they are ACL deficient; however, if and when this may occur remains unknown.

Both groups showed a significant decrease in TSK-11 scores from the end of preoperative rehabilitation to 6 months after ACL reconstruction, but the reduction in kinesiophobia was larger in noncopers. Additionally, the reductions in kinesiophobia were significantly related to self-reported knee function during daily activities in noncopers only. These findings suggest that restoring knee stability has a beneficial effect on kinesiophobia levels, and individuals with poorer dynamic stability benefit the most. However, to more directly determine the effect of ACL reconstruction, it would be necessary to measure kinesiophobia levels sooner than 6 months postsurgery. In addition, comparison to a control group that did not have surgery would provide insight on whether the reductions in kinesiophobia occur over time regardless of surgical status. Importantly, the reductions in TSK-11 scores in this

time frame were the largest across the study and met the criteria for a minimal clinically important difference.⁵⁴

Interestingly, surveys of orthopaedic surgeons in the United States show that they often discuss fear of reinjury with athletes,³⁶ and most surgeons agree that athletes with ACL deficiency will be unable to participate in all recreational sporting activities without surgery.³⁷ The large decrease in kinesiophobia after surgery could also reflect expectations passed between surgeons and patients,⁸ with the recommendation for ACL reconstruction influencing patient expectations that surgery is necessary to restore knee stability. Pain studies have shown that outcomes are related to expectations suggested to, or perceived by, the patient.^{7,9} Specifically, better outcomes were observed when there was an expectation that the intervention would be successful and worse outcomes were observed when low expectations were suggested to the patient.^{7,9} Additionally, a social-learning response can occur when one observes a positive response to an intervention.¹⁶ For example, the knowledge of a known sports figure, teammate, or friend returning to sports after ACL reconstruction may instill a positive expectation that surgery will be a successful intervention. Thus, in the United States, the expectation that ACL reconstruction is needed to return to preinjury levels may contribute to high kinesiophobia levels preoperatively and reduced kinesiophobia after ACL reconstruction.

TSK-11 scores were not different between noncoper and potential copers groups at 6 or 12 months after ACL reconstruction. Similar kinesiophobia levels after ACL reconstruction indicate that the effect of preoperative group assignment on kinesiophobia does not extend to the postoperative period. TSK-11 scores in noncopers (16.15 points) and potential copers (16.90 points) were similar to those reported for other athletes (17.75 points)³² at 6 months after ACL reconstruction; however, noncoper scores (14.98 points) and potential copers scores (15.28 points) at 12 months were lower than those at 12 months postoperation reported elsewhere (18.23 points).³² Importantly, both groups' mean TSK-11 scores at 6 months postsurgery fell between the scores reported for people who did (15.3 points) and did not (19.6 points) return to sports at 12 months postsurgery,³³ suggesting that not all members of either group are psychologically ready to return to sports, whereas by 12 months after ACL reconstruction, the mean TSK-11 scores in both groups (noncopers, 14.98; potential copers, 15.28) were more similar to TSK-11 scores of those who had returned to preinjury sports 12 months after ACL reconstruction (15.3 points).³³ Though the purpose of this investigation was not to compare clinical measures between the noncopers and potential copers postoperatively, quadriceps strength indexes and self-reported and performance-based (hop tests) knee outcomes of both groups appear similar, and the clinical measures were greater than 90% at both postoperative time points for noncopers and potential copers (TABLE 4). Although, clinically, values greater than or equal to 90% meet the established criteria to clear a patient to return to sport,¹ individual performance is not reflected in average performance measures, as less than half of noncopers passed established criteria to return to sports 6 months after surgery.²⁴ Perhaps kinesiophobia levels influence the large variability in noncopers who pass criteria to return to sport 6 months after ACL reconstruction,²⁴ especially given the relationship between kinesiophobia levels and the established return-to-sport criterion of a KOS-ADL score of greater than or equal to 90%.

TSK-11 scores continued to decrease from 6 to 12 months after surgery, despite the already large decreases in kinesiophobia levels from presurgery to 6 months after surgery. Although the postoperative reductions in TSK-11 scores were significant, the magnitude of change was less than 4 points, which is similar to that found by Lentz and colleagues.³² Thus, the magnitude did not reach the threshold for a clinically meaningful reduction as determined in low back pain research.⁵⁴ The limited reductions in kinesiophobia suggest that we need to identify people with continued high kinesiophobia and then address it. Though reductions in kinesiophobia from 6 to 12 months after surgery were not clinically meaningful, these reductions were significantly related to improvements in self-reported knee function during activities of daily living for noncopers and potential copers. No statistically significant relationships between reduced kinesiophobia and improved quadriceps strength symmetry and improved symmetry on the 6-meter timed hop test were found. Others also found significant relationships between kinesiophobia and self-reported knee function during daily activities but not between kinesiophobia and quadriceps strength and hop score indexes.³² Performance-based (eg, muscle strength and dynamic hop tests) and patient self-reported knee function measures appear to represent 2 distinct and different constructs.³⁴ Also, psychological recovery and physical recovery have previously been reported to not occur simultaneously.^{5,30,41} Perhaps self-reported knee function is influenced by patient perception, or maybe performance-based function is the sum total of many factors, including kinesiophobia, strength, and neuromuscular control, and the influence of kinesiophobia does not predominate across patients after ACL rupture and reconstruction. It is also possible that kinesiophobia and self-reported deficits in knee function may not be captured by maximal quadriceps strength indexes and maximal hop score indexes alone. In addition, kinesiophobia may be justified by a mismatch between physical ability and demands, and other aspects of physical performance that were not measured in our study may be associated with kinesiophobia. Perhaps when increased levels of kinesiophobia are present, additional physical impairments, environmental/activity demands, and psychological considerations should all be considered as potential contributors to worse knee stability. Though many questions remain, the need to continue to address factors that influence kinesiophobia throughout the late phases of recovery is evident, as those who become less fearful of reinjury also report fewer limitations in their activities of daily living.³²

Physical therapists should be aware that the TSK-11 questionnaire can be used to measure kinesiophobia levels after ACL rupture and reconstruction. Noncopers have greater kinesiophobia preoperatively, but have the potential to reach kinesiophobia levels similar to those reported for individuals who have returned to sports 12 months after ACL reconstruction.³³ A better understanding of factors that influence kinesiophobia levels is needed, so that interventions can be targeted to individuals who will benefit the most. Our findings indicate that differences in dynamic knee stability following ACL injury appear to influence kinesiophobia levels preoperatively but not postoperatively. Therefore, further research is needed to determine the factors that cause some people to continue to have high kinesiophobia levels. In addition, interventions will be needed to reduce kinesiophobia levels in these individuals. Because kinesiophobia levels are elevated early after ACL rupture and contribute to postoperative reduction or cessation of sports participation,⁵ future research is warranted to investigate the efficacy of psychological interventions. Psychological

counseling or interventions to address psychological recovery that parallel physical recovery are recommended after traumatic injury⁵¹; thus, counseling/interventions that address kinesiophobia may benefit patients who sustain an ACL rupture. Measures of physical, psychological, and self-reported knee function should be evaluated independently to provide a comprehensive picture of each athlete's progression throughout recovery after ACL injury and rehabilitation and perhaps addressed separately.

Limitations

Our findings may not extend to a more sedentary population or to people with multiple ligamentous injury. All patients in this study were level 1 and 2 athletes,²⁵ who incurred a unilateral ACL rupture, received preoperative and postoperative care at the same clinic, and underwent ACL reconstruction by the same orthopaedic surgeon using a hamstring autograft or allograft. Therefore, our findings cannot be generalized to patients who do not fit our inclusion criteria. Also, about 30% of the TSK-11 scores were missing, and such a high rate of missing data might have undermined the precision of our estimates. Although TSK-11 scores were missing at random, and a regression imputation method was used to handle missing data points, an estimated value is less precise than a measured one.² Regression imputation uses a single-value imputation method, which tends to underestimate variances and overestimate correlations, and may introduce additional sampling variability that is not adequately accounted for.² Furthermore, the change in TSK-11 scores that occurs over time may not be linear in nature, which could not be accounted for in regression imputation.

CONCLUSION

Kinesiophobia levels were elevated prior to ACL reconstruction, especially in those with poorer dynamic knee stability (ie, noncopers). After ACL reconstruction, kinesiophobia levels reduced the most in noncopers, and the reductions in kinesiophobia were significantly related to improvements in self-reported knee function during activities of daily living. Clinically, kinesiophobia levels remained high at 6 months and plateaued between 6 and 12 months postsurgery, when athletes are typically cleared to return to sports. Kinesiophobia levels should be monitored from the time of ACL rupture to 12 months after surgery.

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REFERENCES

1. Adams D, Logerstedt DS, Hunter-Giordano A, Axe MJ, Snyder-Mackler L. Current concepts for anterior cruciate ligament reconstruction: a criterion-based rehabilitation progression. *J Orthop*

- Sports Phys Ther. 2012; 42:601–614. <http://dx.doi.org/10.2519/jospt.2012.3871>. [PubMed: 22402434]
2. Allison PD. Missing data techniques for structural equation modeling. *J Abnorm Psychol.* 2003; 112:545–557. <http://dx.doi.org/10.1037/0021-843X.112.4.545>. [PubMed: 14674868]
 3. Ardern CL, Taylor NF, Feller JA, Webster KE. Return-to-sport outcomes at 2 to 7 years after anterior cruciate ligament reconstruction surgery. *Am J Sports Med.* 2012; 40:41–48. <http://dx.doi.org/10.1177/0363546511422999>. [PubMed: 21946441]
 4. Ardern CL, Webster KE, Taylor NF, Feller JA. Return to the preinjury level of competitive sport after anterior cruciate ligament reconstruction surgery: two-thirds of patients have not returned by 12 months after surgery. *Am J Sports Med.* 2011; 39:538–543. <http://dx.doi.org/10.1177/0363546510384798>. [PubMed: 21098818]
 5. Ardern CL, Webster KE, Taylor NF, Feller JA. Return to sport following anterior cruciate ligament reconstruction surgery: a systematic review and meta-analysis of the state of play. *Br J Sports Med.* 2011; 45:596–606. <http://dx.doi.org/10.1136/bjsm.2010.076364>. [PubMed: 21398310]
 6. Baer GS, Harner CD. Clinical outcomes of allograft versus autograft in anterior cruciate ligament reconstruction. *Clin Sports Med.* 2007; 26:661–681. <http://dx.doi.org/10.1016/j.csm.2007.06.010>. [PubMed: 17920959]
 7. Benedetti F, Pollo A, Lopiano L, Lanotte M, Vighetti S, Rainero I. Conscious expectation and unconscious conditioning in analgesic, motor, and hormonal placebo/nocebo responses. *J Neurosci.* 2003; 23:4315–4323. [PubMed: 12764120]
 8. Bialosky JE, Bishop MD, George SZ, Robinson ME. Placebo response to manual therapy: something out of nothing? *J Man Manip Ther.* 2011; 19:11–19. <http://dx.doi.org/10.1179/2042618610Y.0000000001>. [PubMed: 22294849]
 9. Bishop MD, Bialosky JE, Cleland JA. Patient expectations of benefit from common interventions for low back pain and effects on outcome: secondary analysis of a clinical trial of manual therapy interventions. *J Man Manip Ther.* 2011; 19:20–25. <http://dx.doi.org/10.1179/106698110X12804993426929>. [PubMed: 22294850]
 10. Bjordal JM, Arnøy F, Hannestad B, Strand T. Epidemiology of anterior cruciate ligament injuries in soccer. *Am J Sports Med.* 1997; 25:341–345. <http://dx.doi.org/10.1177/036354659702500312>. [PubMed: 9167814]
 11. Chmielewski TL, Hurd WJ, Snyder-Mackler L. Elucidation of a potentially destabilizing control strategy in ACL deficient non-copers. *J Electromyogr Kinesiol.* 2005; 15:83–92. <http://dx.doi.org/10.1016/j.jelekin.2004.07.003>. [PubMed: 15642656]
 12. Chmielewski TL, Jones D, Day T, Tillman SM, Lentz TA, George SZ. The association of pain and fear of movement/reinjury with function during anterior cruciate ligament reconstruction rehabilitation. *J Orthop Sports Phys Ther.* 2008; 38:746–753. <http://dx.doi.org/10.2519/jospt.2008.2887>. [PubMed: 19047767]
 13. Chmielewski TL, Ramsey DK, Snyder-Mackler L. Evidence for differential control of tibial position in perturbed unilateral stance after acute ACL rupture. *J Orthop Res.* 2005; 23:54–60. <http://dx.doi.org/10.1016/j.orthres.2004.05.011>. [PubMed: 15607875]
 14. Chmielewski TL, Rudolph KS, Fitzgerald GK, Axe MJ, Snyder-Mackler L. Biomechanical evidence supporting a differential response to acute ACL injury. *Clin Biomech (Bristol, Avon).* 2001; 16:586–591.
 15. Chmielewski TL, Zeppieri G Jr, Lentz TA, et al. Longitudinal changes in psychosocial factors and their association with knee pain and function after anterior cruciate ligament reconstruction. *Phys Ther.* 2011; 91:1355–1366. <http://dx.doi.org/10.2522/ptj.20100277>. [PubMed: 21700761]
 16. Colloca L, Benedetti F. Placebo analgesia induced by social observational learning. *Pain.* 2009; 144:28–34. <http://dx.doi.org/10.1016/j.pain.2009.01.033>. [PubMed: 19278785]
 17. Daniel DM, Stone ML, Sachs R, Malcom L. Instrumented measurement of anterior knee laxity in patients with acute anterior cruciate ligament disruption. *Am J Sports Med.* 1985; 13:401–407. <http://dx.doi.org/10.1177/036354658501300607>. [PubMed: 4073348]
 18. Eastlack ME, Axe MJ, Snyder-Mackler L. Laxity, instability, and functional outcome after ACL injury: copers versus noncopers. *Med Sci Sports Exerc.* 1999; 31:210–215. [PubMed: 10063808]

19. Fitzgerald GK, Axe MJ, Snyder-Mackler L. A decision-making scheme for returning patients to high-level activity with nonoperative treatment after anterior cruciate ligament rupture. *Knee Surg Sports Traumatol Arthrosc.* 2000; 8:76–82. [PubMed: 10795668]
20. Fitzgerald GK, Axe MJ, Snyder-Mackler L. The efficacy of perturbation training in nonoperative anterior cruciate ligament rehabilitation programs for physical active individuals. *Phys Ther.* 2000; 80:128–140. [PubMed: 10654060]
21. Fitzgerald GK, Axe MJ, Snyder-Mackler L. Proposed practice guidelines for nonoperative anterior cruciate ligament rehabilitation of physically active individuals. *J Orthop Sports Phys Ther.* 2000; 30:194–203. <http://dx.doi.org/10.2519/jospt.2000.30.4.194>. [PubMed: 10778796]
22. Grittner U, Gmel G, Ripatti S, Bloomfield K, Wicki M. Missing value imputation in longitudinal measures of alcohol consumption. *Int J Methods Psychiatr Res.* 2011; 20:50–61. <http://dx.doi.org/10.1002/mpr.330>. [PubMed: 21556290]
23. Hartigan E, Axe MJ, Snyder-Mackler L. Perturbation training prior to ACL reconstruction improves gait asymmetries in non-copers. *J Orthop Res.* 2009; 27:724–729. <http://dx.doi.org/10.1002/jor.20754>. [PubMed: 19023893]
24. Hartigan EH, Axe MJ, Snyder-Mackler L. Time line for noncopers to pass return-to-sports criteria after anterior cruciate ligament reconstruction. *J Orthop Sports Phys Ther.* 2010; 40:141–154. <http://dx.doi.org/10.2519/jospt.2010.3168>. [PubMed: 20195019]
25. Hefti F, Müller W, Jakob RP, Stäubli HU. Evaluation of knee ligament injuries with the IKDC form. *Knee Surg Sports Traumatol Arthrosc.* 1993; 1:226–234. <http://dx.doi.org/10.1007/BF01560215>. [PubMed: 8536037]
26. Hurd WJ, Axe MJ, Snyder-Mackler L. A 10-year prospective trial of a patient management algorithm and screening examination for highly active individuals with anterior cruciate ligament injury: part 1, outcomes. *Am J Sports Med.* 2008; 36:40–47. <http://dx.doi.org/10.1177/0363546507308190>. [PubMed: 17940141]
27. Irrgang JJ, Snyder-Mackler L, Wainner RS, Fu FH, Harner CD. Development of a patient-reported measure of function of the knee. *J Bone Joint Surg Am.* 1998; 80:1132–1145. [PubMed: 9730122]
28. Kleinbaum, DG.; Kupper, LL.; Muller, KE.; Nizam, A. *Applied Regression Analysis and Other Multivariable Methods.* 3rd. Pacific Grove, CA: Duxbury Press; 1993.
29. Kvist J, Ek A, Sporrstedt K, Good L. Fear of re-injury: a hindrance for returning to sports after anterior cruciate ligament reconstruction. *Knee Surg Sports Traumatol Arthrosc.* 2005; 13:393–397. <http://dx.doi.org/10.1007/s00167-004-0591-8>. [PubMed: 15703963]
30. Langford JL, Webster KE, Feller JA. A prospective longitudinal study to assess psychological changes following anterior cruciate ligament reconstruction surgery. *Br J Sports Med.* 2009; 43:377–381. <http://dx.doi.org/10.1136/bjsm.2007.044818>. [PubMed: 19019910]
31. Lee DY, Karim SA, Chang HC. Return to sports after anterior cruciate ligament reconstruction – a review of patients with minimum 5-year follow-up. *Ann Acad Med Singapore.* 2008; 37:273–278. [PubMed: 18461210]
32. Lentz TA, Tillman SM, Indelicato PA, Moser MW, George SZ, Chmielewski TL. Factors associated with function after anterior cruciate ligament reconstruction. *Sports Health.* 2009; 1:47–53. <http://dx.doi.org/10.1177/1941738108326700>. [PubMed: 23015854]
33. Lentz TA, Zeppieri G Jr, Tillman SM, et al. Return to preinjury sports participation following anterior cruciate ligament reconstruction: contributions of demographic, knee impairment, and self-report measures. *J Orthop Sports Phys Ther.* 2012; 42:893–901. <http://dx.doi.org/10.2519/jospt.2012.4077>. [PubMed: 22951437]
34. Logerstedt D, Grindem H, Lynch A, et al. Single-legged hop tests as predictors of self-reported knee function after anterior cruciate ligament reconstruction: the Delaware-Oslo ACL cohort study. *Am J Sports Med.* 2012; 40:2348–2356. <http://dx.doi.org/10.1177/0363546512457551>. [PubMed: 22926749]
35. Manal TJ, Snyder-Mackler L. Practice guidelines for anterior cruciate ligament rehabilitation: a criterion-based rehabilitation progression. *Oper Tech Orthop.* 1996; 6:190–196.
36. Mann BJ, Grana WA, Indelicato PA, O'Neill DF, George SZ. A survey of sports medicine physicians regarding psychological issues in patient-athletes. *Am J Sports Med.* 2007; 35:2140–2147. <http://dx.doi.org/10.1177/0363546507304140>. [PubMed: 17641103]

37. Marx RG, Jones EC, Angel M, Wickiewicz TL, Warren RF. Beliefs and attitudes of members of the American Academy of Orthopaedic Surgeons regarding the treatment of anterior cruciate ligament injury. *Arthroscopy*. 2003; 19:762–770. [PubMed: 12966385]
38. Moksnes H, Snyder-Mackler L, Risberg MA. Individuals with an anterior cruciate ligament-deficient knee classified as noncopers may be candidates for nonsurgical rehabilitation. *J Orthop Sports Phys Ther*. 2008; 38:586–595. <http://dx.doi.org/10.2519/jospt.2008.2750>. [PubMed: 18979658]
39. Noyes FR, Barber SD, Mangine RE. Abnormal lower limb symmetry determined by function hop tests after anterior cruciate ligament rupture. *Am J Sports Med*. 1991; 19:513–518. <http://dx.doi.org/10.1177/036354659101900518>. [PubMed: 1962720]
40. Pigott, TD. *Advances in Meta-Analysis*. New York, NY: Springer; 2012.
41. Podlog L, Eklund RC. The psychosocial aspects of a return to sport following serious injury: a review of the literature from a self-determination perspective. *Psych Sport Exerc*. 2007; 8:535–566.
42. Portney, LG.; Watkins, MP. *Foundations of Clinical Research: Applications to Practice*. 3rd. Upper Saddle River, NJ: Pearson/Prentice Hall; 2008.
43. Reid A, Birmingham TB, Stratford PW, Alcock GK, Giffin JR. Hop testing provides a reliable and valid outcome measure during rehabilitation after anterior cruciate ligament reconstruction. *Phys Ther*. 2007; 87:337–349. <http://dx.doi.org/10.2522/ptj.20060143>. [PubMed: 17311886]
44. Roelofs J, Sluiter JK, Frings-Dresen MH, et al. Fear of movement and (re)injury in chronic musculoskeletal pain: evidence for an invariant two-factor model of the Tampa Scale for Kinesiophobia across pain diagnoses and Dutch, Swedish, and Canadian samples. *Pain*. 2007; 131:181–190. <http://dx.doi.org/10.1016/j.pain.2007.01.008>. [PubMed: 17317011]
45. Rudolph KS, Axe MJ, Buchanan TS, Scholz JP, Snyder-Mackler L. Dynamic stability in the anterior cruciate ligament deficient knee. *Knee Surg Sports Traumatol Arthrosc*. 2001; 9:62–71. [PubMed: 11354855]
46. Rudolph KS, Eastlack ME, Axe MJ, Snyder-Mackler L. Basmajian Student Award paper: movement patterns after anterior cruciate ligament injury: a comparison of patients who compensate well for the injury and those who require operative stabilization. *J Electromyogr Kinesiol*. 1998; 8:349–362. 1998. [PubMed: 9840891]
47. Shrive FM, Stuart H, Quan H, Ghali WA. Dealing with missing data in a multi-question depression scale: a comparison of imputation methods. *BMC Med Res Methodol*. 2006; 6:57. <http://dx.doi.org/10.1186/1471-2288-6-57>. [PubMed: 17166270]
48. Snyder-Mackler L, Delitto A, Bailey SL, Stralka SW. Strength of the quadriceps femoris muscle and functional recovery after reconstruction of the anterior cruciate ligament. A prospective, randomized clinical trial of electrical stimulation. *J Bone Joint Surg Am*. 1995; 77:1166–1173. [PubMed: 7642660]
49. Snyder-Mackler L, De Luca PF, Williams PR, Eastlack ME, Bartolozzi AR 3rd. Reflex inhibition of the quadriceps femoris muscle after injury or reconstruction of the anterior cruciate ligament. *J Bone Joint Surg Am*. 1994; 76:555–560. [PubMed: 8150823]
50. Sturgill LP, Snyder-Mackler L, Manal TJ, Axe MJ. Interrater reliability of a clinical scale to assess knee joint effusion. *J Orthop Sports Phys Ther*. 2009; 39:845–849. <http://dx.doi.org/10.2519/jospt.2009.3143>. [PubMed: 20032559]
51. Webster KE, Feller JA, Lambros C. Development and preliminary validation of a scale to measure the psychological impact of returning to sport following anterior cruciate ligament reconstruction surgery. *Phys Ther Sport*. 2008; 9:9–15. <http://dx.doi.org/10.1016/j.ptsp.2007.09.003>. [PubMed: 19083699]
52. Wilk KE, Macrina LC, Cain EL, Dugas JR, Andrews JR. Recent advances in the rehabilitation of anterior cruciate ligament injuries. *J Orthop Sports Phys Ther*. 2012; 42:153–171. <http://dx.doi.org/10.2519/jospt.2012.3741>. [PubMed: 22382825]
53. Wilk KE, Simoneau GG. Managing knee injuries: keeping up with changes. *J Orthop Sports Phys Ther*. 2012; 42:150–152. <http://dx.doi.org/10.2519/jospt.2012.0104>. [PubMed: 22382777]

54. Woby SR, Roach NK, Urmston M, Watson PJ. Psychometric properties of the TSK-11: a shortened version of the Tampa Scale for Kinesiophobia. *Pain*. 2005; 117:137–144. <http://dx.doi.org/10.1016/j.pain.2005.05.029>. [PubMed: 16055269]
55. Wroble RR, Van Ginkel LA, Grood ES, Noyes FR, Shaffer BL. Repeatability of the KT-1000 arthrometer in a normal population. *Am J Sports Med*. 1990; 18:396–399. <http://dx.doi.org/10.1177/036354659001800411>. [PubMed: 2403189]

KEY POINTS

FINDINGS

Kinesiophobia levels were highest preoperatively and decreased after surgery. Noncopers had greater kinesiophobia preoperatively, and larger decreases postsurgery resolved group differences. Noncopers who reported less difficulty/symptoms with daily function from presurgery to postsurgery had less kinesiophobia, and this fair and significant relationship between reported gains in perceived daily knee function and less kinesiophobia was present postsurgery for noncopers and potential copers.

IMPLICATIONS

The larger change in TSK-11 scores from presurgery to postsurgery in noncopers suggests that improved knee stability helps decrease kinesiophobia. The lack of a significant relationship between kinesiophobia and functional performance suggests the need to address high levels of kinesiophobia even if quadriceps strength and hop scores are symmetrical. Kinesiophobia levels did not reach levels similar to those who returned to sport until 12 months postsurgery.

CAUTION

All patients were level 1 or level 2 athletes, underwent ACL reconstruction by the same orthopaedic surgeon, received a hamstring autograft or allograft, and completed presurgery and postsurgery care at the same clinic. These factors limit the generalizability of our findings.

FIGURE 1.

An example of multiple imputation with observed versus predicted (eg, expected) TSK-11 values after preoperative treatment. Abbreviation: TSK-11, Tampa Scale of Kinesiophobia.

FIGURE 2.

Flow diagram. Abbreviations: ACL, anterior cruciate ligament; NC, noncopper; PC, potential copper; TSK-11, Tampa Scale of Kinesiophobia.

FIGURE 3.

TSK-11 scores at all 4 time points. Data are mean $\pm$ SD ($n = 111$). *Significant difference between groups at both preoperative times and a significant change between time points for each group ($P < .05$). Abbreviations: NC, noncoper; PC, potential coper; TSK-11, Tampa Scale of Kinesiophobia; tx, treatment.

TABLE 1

Cutoff Criteria Used to Classify Noncopers and Potential Copers

	Meeting All 4 Criteria Below Classifies a Patient as a Potential Coper	Meeting Any 1 of the Criteria Below Classifies a Patient as a Noncoper
Self-reported episode of the knee giving way	1	>1
Single-leg 6-meter timed hop index	80%	<80%
Knee Outcome Survey activities of daily living subscale	80%	<80%
Global rating scale score	60%	<60%

TABLE 2

Demographic Data Collected Before Presurgery Treatment (Screening Examination) for All 111 Patients *

Characteristic	Value
Sex, n	
Female	34
Male	77
Age, y	26.7 ± 10.9
Time from injury to evaluation, d	38.3 ± 47.6
Height, m	1.75 ± 0.09
Weight, kg	80.7 ± 16.8

* Values are mean ± SD unless otherwise indicated.

TABLE 3

TSK-11 Scores Over Time for Noncopers and Potential Copers, With Data for All 4 Time Points and for All Patients *

	Before Preoperative Treatment	After Preoperative Treatment	6 mo Postoperation	12 mo Postoperation
Noncopers				
TSK-11 scores observed throughout (n = 22)	26.0 ± 6.5	23.9 ± 6.5	15.6 ± 3.4	14.6 ± 3.7
With imputed TSK-11 scores (n = 61)	25.3 ± 5.1	23.1 ± 5.0	16.2 ± 3.7	15.0 ± 3.4
Potential copers				
TSK-11 scores observed throughout (n = 16)	22.6 ± 5.5	20.6 ± 5.8	17.8 ± 4.8	15.4 ± 4.6
With imputed TSK-11 scores (n = 50)	22.9 ± 4.4	20.9 ± 4.9	16.9 ± 4.5	15.3 ± 4.0

Abbreviation: TSK-11, Tampa Scale of Kinesiophobia.

* Values are mean ± SD.

TABLE 4

Descriptive Statistics for All 111 Patients Separated by Group and Time *

Time Point/Variable	Potential Copers With TSK-11 Data	Noncopers With TSK-11 Data
Before preoperative treatment		
Quadriceps index	91.64 ± 13.38	87.98 ± 12.92
Single hop	92.92 ± 12.09	76.28 ± 18.19
Crossover hop	95.49 ± 13.92	60.96 ± 38.65
Triple hop	93.20 ± 9.69	59.03 ± 37.30
6-meter timed hop	96.33 ± 7.14	61.52 ± 40.83
KOS-ADL	91.87 ± 5.54	74.87 ± 12.62
Global rating scale	81.10 ± 10.70	64.59 ± 18.16
TSK-11	22.93 ± 4.44	25.30 ± 5.13
After preoperative treatment		
Quadriceps index	96.30 ± 13.75	91.23 ± 16.11
Single hop	97.67 ± 8.71	84.17 ± 15.50
Crossover hop	98.52 ± 9.37	88.67 ± 11.85
Triple hop	97.73 ± 9.40	87.08 ± 9.17
6-meter timed hop	98.68 ± 7.69	92.03 ± 12.40
KOS-ADL	95.16 ± 5.09	86.17 ± 9.34
Global rating scale	87.00 ± 12.59	76.02 ± 13.12
TSK-11	20.92 ± 4.88	23.10 ± 4.97
6 mo postoperation		
Quadriceps index	97.06 ± 12.26	96.74 ± 12.93
Single hop	96.62 ± 10.12	92.33 ± 8.10
Crossover hop	97.87 ± 8.09	94.44 ± 15.66
Triple hop	96.79 ± 5.77	93.48 ± 14.78
6-meter timed hop	97.24 ± 7.91	95.25 ± 15.79
KOS-ADL	97.72 ± 2.62	96.48 ± 3.47
Global rating scale	92.57 ± 6.38	93.00 ± 6.10
TSK-11	16.90 ± 4.50	16.15 ± 3.70
12 mo postoperation		
Quadriceps index	99.97 ± 13.16	97.57 ± 11.98
Single hop	99.64 ± 7.92	95.98 ± 7.11
Crossover hop	99.74 ± 7.69	96.63 ± 8.17
Triple hop	95.36 ± 17.82	96.70 ± 6.60
6-meter timed hop	97.14 ± 18.56	98.34 ± 6.30
KOS-ADL	98.90 ± 1.59	97.41 ± 3.43
Global rating scale	96.66 ± 5.95	96.29 ± 4.72
TSK-11	15.28 ± 3.99	14.98 ± 3.43

Abbreviations: KOS-ADL, Knee Outcome Survey activities of daily living subscale; TSK-11, Tampa Scale of Kinesiophobia.

* Values are mean ± SD.