

Injury-Related Fears During the Return-to-Sport Phase of ACL Reconstruction Rehabilitation

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Background: Fear of reinjury is common after anterior cruciate ligament reconstruction (ACLR) and often deters a return to preinjury sport participation. A better understanding of injury-related fear is needed to inform rehabilitation strategies.

Purpose/Hypothesis: The purpose of this study was to (1) identify individual fear-evoking tasks or situations, (2) compare the intensity and amount of change relative to other injury-related fears (reinjury, knee giving way, and knee pain) after completion of a return-to-sport training program, and (3) determine whether standardized questionnaires can identify the intensity of fear for the individual fear-evoking task or situation and for fear of reinjury. The hypothesis was that the task or situation that evokes fear would vary across patients and the intensity of that fear would be higher and show less change after return-to-sport training compared with other injury-related fears.

Study Design: Case series; Level of evidence, 4.

Methods: Participants included 33 patients (15 males; mean age, 18 years) with ACLR who enrolled in a group-format return-to-sport training program. Questionnaires completed before and after return-to-sport training included items to specify fear-evoking tasks or situations, items to rate the intensity of various injury-related fears, the Anterior Cruciate Ligament Return to Sport after Injury scale (ACL-RSI), and the Tampa Scale for Kinesiophobia (TSK-11).

Results: The most common fear-evoking task or situation was cutting, followed by contact, jumping, and other. Intensity of fear-evoking task or situation was higher than other injury-related fears, but all fears decreased in intensity after training. The ACL-RSI score better identified the intensity of fear for the individual fear-evoking task or situation and for fear of reinjury than did the TSK-11 score.

Conclusion: Activities that evoke fear vary across patients, but fear of cutting is common. The intensity of common fears after ACLR decreased after advanced group training, and large effect sizes were seen for nearly all examined fears. Fear of reinjury and intensity of individually feared tasks may be better reflected in the ACL-RSI score than the TSK-11 score.

Keywords: fear of reinjury; return to sport; psychological readiness; anterior cruciate ligament

Despite advances in anterior cruciate ligament reconstruction (ACLR) rehabilitation,^{1,23} the rate of return to preinjury or competitive sport in the general population is approximately 45% to 60%.^{4,5} Fear of reinjury is the primary reason given by patients for not resuming preinjury sports participation.^{2,5,9,15} The translation of this knowledge to clinical practice is evolving. Recent commentaries recommended that psychological responses, such as fear of reinjury, be considered along with physical measures when a clinician is deciding whether a patient is ready to resume sports participation,¹⁹ reinforcing a recommendation made

more than 30 years ago.⁸ However, to do this, clinicians need strategies to assess and treat, when appropriate, fear of reinjury.

The presence of fear of reinjury could be ascertained by asking whether it is experienced,¹⁸ but this does not provide insight into the intensity of the fear or what contributes to the fear. The Anterior Cruciate Ligament Return to Sport after Injury (ACL-RSI) scale and Tampa Scale for Kinesiophobia (TSK-11) have been used in ACLR research to quantify injury-related fear. The ACL-RSI assesses psychological readiness for sport participation in the domains of emotion, confidence, and risk appraisal and includes an item that asks, "Are you fearful of reinjuring your knee by playing your sport?"¹³ In contrast, TSK-11 assesses kinesiophobia, or pain-related fear of movement/reinjury, which

The Orthopaedic Journal of Sports Medicine, 8(3), 2325967120909385
DOI: 10.1177/2325967120909385
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is a construct from the fear-avoidance model that was created to explain the development of chronic pain and pain-limited activity.^{17,28} The TSK-11 is not specific to sports participation, but one item states, “I am afraid that I might injure myself if I exercise.” Although ACL-RSI and TSK-11 scores might provide insight into the intensity of injury-related fear, the interpretation of the cause would be sport (ACL-RSI) or exercise participation (TSK-11) in general.

Further understanding of what contributes to injury-related fear could be critical to inform effective intervention. Graded exposure is used to address fears and phobias in other populations, and it requires identifying the source of the fear and then hierarchically and incrementally exposing the patient to the source in order to facilitate a confrontational response.¹² If the source is not identified, graded exposure cannot be implemented. It is possible that the source of fear is individual to each patient, and fear of reinjury might persist because the specific source is not addressed in standard rehabilitation.

The purpose of this study was to identify individual injury-related fears after ACLR and to compare both the intensity and amount of change after return-to-sport training between various injury-related fears. The hypothesis was that the specific task or situation that evokes fear would vary across patients and that the intensity of that fear would be higher and show less change after return-to-sport training compared with other injury-related fears.

METHODS

Study Overview

This is a secondary analysis of data collected in a prospective study comparing psychological and functional outcomes in patients with ACLR who did or did not participate in a group return-to-sport training program. Specifically, this study analyzed demographic information and responses on injury-related fear questionnaires in the training cohort.

Participants

Patients who had completed traditional physical therapy and voluntarily participated in a return-to-sport training program between August 2016 and May 2018 were considered eligible for the study. All patients had completed traditional physical therapy before enrolling. Inclusion criteria were age 14 to 30 years at the time of surgery; undergoing primary ACLR; preinjury participation in

competitive sports that require cutting, jumping, or pivoting, with intention to return to the same level after surgery; being a minimum 5 months postoperative; knee range of motion with full extension and active flexion within 5° of the contralateral knee; ability to hop vertically on the surgical leg without pain or instability; trace effusion or less; and surgeon approval to begin return-to-sport training. Exclusion criteria were previous lower extremity surgery or additional surgical procedures that altered postoperative rehabilitation (ie, concomitant meniscal or ligamentous repair or cartilage-stimulating procedure) or completion of a similar return-to-sport program at another facility. Patients gave written consent or assent (minor participants) to participate in this study on a form approved by the institutional review board at the University of Minnesota.

Injury-Related Fear Questionnaires

Patients completed a battery of questionnaires. One questionnaire asked patients to “identify the top 3 tasks for which you are most afraid.” Prompts included tasks from the Knee Activity Self-efficacy Scale⁶ (ie, running, stopping and starting quickly, quickly changing direction while running, jumping straight up and landing on both legs, jumping forward and landing on both legs, jumping onto an 8-inch step, jumping down from an 8-inch step and landing on both legs, hopping on 1 leg, and being hit on the side of the knee), but the instructions advised patients to “feel free to write in other tasks.” Patients were also asked to rate the intensity of fear for each task on a scale from 0 (no fear) to 10 (greatest fear imaginable). The primary (top-ranked) fear-evoking task or situation and corresponding fear intensity was used for analysis.

Another questionnaire asked patients to rate the intensity of 3 specific injury-related fears: fear of reinjuring the knee during activity, fear of the knee giving way during activity, and fear of experiencing knee pain during activity. The rationale for selecting these specific fears is that the intensity of fear of reinjury has not been reported previously, fear of knee giving way is a preoperative fear,²⁶ and fear of pain should underlie elevated kinesiophobia after ACLR.¹⁴ Patients rated the intensity of these fears on a 10-cm visual analog scale, with 0 representing “no fear” and 10 representing “extremely fearful.”

Finally, patients completed ACL-RSI and TSK-11 questionnaires. The ACL-RSI has 12 questions, including 2 questions that specifically query fear of reinjury, and gives a composite score ranging from 0 to 100, where higher

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Final revision submitted December 12, 2019; accepted December 17, 2019.

One or more of the authors has declared the following potential conflict of interest or source of funding: B.J.N. has received research support from Histogenics and Regentis, educational support from Arthrex, and consulting fees from Marrow Access Technology. M.T. has received research support from DJO. AOSSM checks author disclosures against the Open Payments Database (OPD). AOSSM has not conducted an independent investigation on the OPD and disclaims any liability or responsibility relating thereto.

Ethical approval for this study was obtained from the University of Minnesota Institutional Review Board (ref No. 1605M87601).

scores indicate better psychological readiness for sport. The ACL-RSI has been shown to be valid and reliable in the ACLR population.^{10,16,29} The TSK-11 includes 11 items that are scored from 1 (strongly disagree) to 4 (strongly agree), with a total score ranging from 11 to 44 points and higher scores indicating greater kinesiophobia.³⁰ The TSK-11 has been validated in the ACLR population.¹¹

Return-to-Sport Training Program

The return-to-sport training program has been described previously.^{21,22} It includes 20 hours of supervised training (2 hours per session, 2 sessions per week for 5 weeks) provided to a group of 6 to 8 patients and is staffed with 1 physical therapist and 1 athletic trainer to ensure adequate feedback on appropriate movement patterns. The focus of training is on plyometric, agility, and strengthening exercises to address common deficiencies after ACLR such as improper jump-landing technique. The training program includes standardized exercise progressions and does not include specific treatment for injury-related fear.

Statistical Analysis

Sample size was estimated using an online calculator (<http://statulator.com/SampleSize/ss2PM.html>). Identifying the primary fear-evoking task or situation is descriptive, and no prior work has examined the intensity of ACL-relevant fears. Thus, the sample size was based on detecting a pre- to posttraining change in ACL-RSI score through use of previously reported values.²¹ A sample size of 11 participants was deemed sufficient to detect a pre- to posttraining change in ACL-RSI score with 80% power and a 5% level of significance. Conservatively, the target sample size was doubled to 22 patients.

Statistical analysis was performed with SPSS Statistics Version 24 (IBM Corp). Descriptive statistics were generated for all variables. Normality of continuous variables was confirmed with the Kolmogorov-Smirnov test. Statistical significance was set at $P < .05$ for all analyses.

After responses were reviewed and themes identified, the primary fear-evoking task or situation was categorized as jumping, cutting, contact, or other. The McNemar test was used to examine the pre- to posttraining change in categorization of the primary fear-evoking task or situation. The pretraining intensity of fear for the primary fear-evoking task or situation, fear of knee reinjury, fear of knee giving way, and fear of knee pain were compared through use of a multivariate repeated-measures general linear model. Furthermore, a multivariate repeated-measures general linear model was used to evaluate the pre- to posttraining change in intensity of those injury-related fears as well as scores on ACL-RSI and TSK-11 questionnaires. Means and standard deviations of the pre- to posttraining change were input into an online effect size calculator to allow comparison of the magnitude of change across all measures.

An exploratory analysis was conducted to determine whether ACL-RSI or TSK-11 scores discriminated the intensity of fear for the primary fear-evoking task or

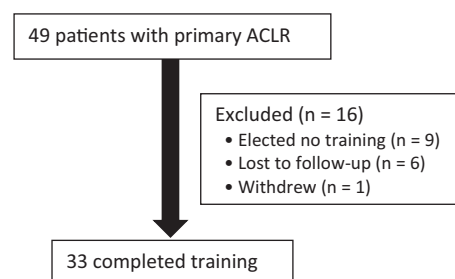


Figure 1. Study enrollment. ACLR, anterior cruciate ligament reconstruction.

TABLE 1
Demographics of the Study Sample^a

| Measure | Result |
|------------------------------------|---------------------------------|
| Sex, n | 18 females, 15 males |
| Injury mechanism, n | 11 contact, 22 noncontact |
| Autograft type, n | 8 hamstring, 25 patellar tendon |
| Age at time of surgery, y | 18.1 ± 4.8 |
| Time from surgery to training, wk | 24.9 ± 3.1 |
| No. of training sessions completed | 9.3 ± 0.7 |

^aValues are expressed as mean ± SD unless otherwise indicated.

situation and for fear of reinjury. Both questionnaires have been used in the ACLR population, and it would be useful to know whether they can distinguish individuals with high intensity on these injury-related fears. At both pre- and posttraining assessments, the median score on each questionnaire was used to split the sample into “low-score” or “high-score” groups. The intensity of fear for the fear-evoking task or situation and for fear of reinjury was then compared between total low- and high-score groups through the use of independent *t* tests.

RESULTS

Of 49 eligible patients, 33 completed the return-to-sport training program (Figure 1). Demographic information can be found in Table 1. All patients successfully completed at least 80% of the training sessions.

Cutting was the most common categorization for the primary fear-evoking task or situation, followed by contact, jumping, and other (Figure 2). The order of prevalence for each category did not change from pre- to posttraining assessments ($P = .96$), although for 15 patients (45%), the categorization of their primary fear-evoking task or situation changed after training. Activities that were categorized as “other” are listed in Table 2.

All ACL-relevant fears decreased after training ($P < .05$) (Table 3). The fear intensity was greatest for the individual fear-evoking task or situation at both pre- and posttraining assessments, whereas the magnitude of change with

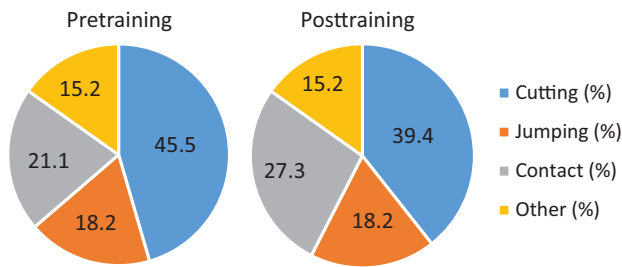


Figure 2. Categorization of primary fear-evoking task or situation.

TABLE 2
Activities Categorized as “Other”

| Pretraining | Posttraining |
|--------------------|-----------------------------|
| – Playing on turf | – Pivoting |
| – Playing lacrosse | – Planting on turf |
| – Running | – Running |
| – Playing defense | – Not being able to return |
| – Pivoting | – Playing high-level soccer |
| – Skiing | – Getting hit from behind |

TABLE 3
Intensity of Fears at Pre- and Posttraining Assessments^a

| Category | Pretraining | Posttraining | Effect Size |
|--------------------------------|-------------|--------------------------|-------------|
| Fear-evoking task or situation | 6.6 ± 2.1 | 4.6 ± 2.8 ^b | –0.86 |
| Fear of reinjuring knee | 4.6 ± 2.6 | 2.6 ± 2.3 ^b | –0.82 |
| Fear of knee giving way | 4.0 ± 2.6 | 1.7 ± 1.8 ^b | –1.06 |
| Fear of knee pain | 3.5 ± 2.7 | 1.9 ± 1.7 ^b | –0.69 |
| ACL-RSI | 65.1 ± 18.1 | 80.1 ± 13.7 ^b | |
| TSK-11 | 20.7 ± 4.6 | 17.6 ± 4.4 ^b | |

^aValues are expressed as mean ± SD. ACL-RSI, Anterior Cruciate Ligament Return to Sport after Injury scale; TSK-11, Tampa Scale for Kinesiophobia.

^bStatistically significant difference compared with pretraining ($P < .05$).

training was greatest for knee giving way. Fear of knee pain had the lowest pretraining fear intensity and smallest change magnitude.

At both time points, the group with a low ACL-RSI total score had significantly greater fear intensity for both primary fear-evoking task or situation and fear of reinjury than did the group with a high ACL-RSI score ($P < .01$) (Table 4). Only the pretraining intensity of fear of reinjury was higher in the high TSK-11 group compared with the low TSK-11 group ($P = .04$).

DISCUSSION

This study examined injury-related fears in patients with ACLR before and after completing a return-to-sport

TABLE 4
Comparison of Fear Intensities for ACL-RSI and TSK-11^a

| | Primary Fear-Evoking Task or Situation | Fear of Reinjuring Knee |
|-------------------------------|--|-------------------------|
| ACL-RSI | | |
| Pretraining | | |
| Low-score group (<64 points) | 7.6 ± 1.3 | 6.0 ± 2.2 |
| High-score group (≥64 points) | 5.6 ± 2.3 | 3.1 ± 2.1 |
| <i>P</i> value | .005 ^b | <.01 ^b |
| Posttraining | | |
| Low-score group (<84 points) | 6.4 ± 1.4 | 4.3 ± 2.1 |
| High-score group (≥85 points) | 2.8 ± 2.6 | 0.9 ± 0.8 |
| <i>P</i> value | <.01 ^b | <.01 ^b |
| TSK-11 | | |
| Pretraining | | |
| Low-score group (<19 points) | 6.1 ± 2.5 | 3.7 ± 2.7 |
| High-score group (≥20 points) | 7.2 ± 1.4 | 5.5 ± 2.2 |
| <i>P</i> value | .14 | .04 ^b |
| Posttraining | | |
| Low-score group (<18 points) | 4.2 ± 3.1 | 2.0 ± 2.4 |
| High-score group (≥19 points) | 5.0 ± 2.2 | 3.2 ± 2.1 |
| <i>P</i> value | .4 | .15 |

^aValues are expressed as mean ± SD. ACL-RSI, Anterior Cruciate Ligament Return to Sport after Injury scale; TSK-11, Tampa Scale for Kinesiophobia.

^bStatistically significant difference between low-score and high-score groups ($P < .05$).

training program. As hypothesized, variability was found between patients in the primary fear-evoking task or situation, although cutting was most common. At both pre- and posttraining assessments, the intensity of fear was greatest for the specific fear-evoking task or situation, followed by fear of reinjury. All injury-related fears decreased after training, but fear of the knee giving way showed the greatest training effect. The study findings indicate that different tasks or activities evoke fear in different patients, fear of reinjury may not be completely addressed through a return-to-sport training program, and the ACL-RSI score has better potential than the TSK-11 score to reflect the intensity of fear of reinjury.

Little is known about activities that evoke fear after ACLR. Implementation of psychologically informed practice, which has been used in treatment of chronic low back pain to address fear impairments, requires understanding what underlies fear of reinjury to allow creation of a graded exposure intervention.^{12,27} At pre- and posttraining assessments, cutting or contact was selected as the primary fear-evoking activity by at least 60% of the sample; however, about 15% of the sample selected individually focused activities (ie, “other” category). Although it would be easy to incorporate graded exposure to cutting activities into rehabilitation, incorporating contact activities would be more difficult. For example, patient care might need to transition to team medical staff, if available, to perform drills involving contact with teammates. Previous work has found that less than 40% of patients met the criterion for psychological

readiness to return to sport (ACL-RSI score >75 points) after participating in a return-to-sport training program.²¹ This may be because the training program focuses on progressively more challenging neuromuscular exercises and not graded exposure to activities that evoke fear. Similarly, previous research found that although confidence improved, there was no change in the fear measure after post-ACLR plyometric training.⁶ These results highlight the need to ascertain from patients the activities that evoke fear and provide an intervention that addresses the fear. Once specific fears are identified, treatment can be organized to gradually expose patients to the feared task or situation.

Examining the intensity of the primary fear-evoking situation or task relative to the fear of reinjury, fear of knee giving way, and fear of knee pain allows an estimation of the hierarchy of injury-related fears and the response to return to sport training. In our study, fear of reinjury had higher intensity than fear of giving way or knee pain at both pre- and posttraining assessments, which is not unexpected because fear of reinjury is commonly reported after ACLR.^{2,15,18} Interestingly, however, the fear-evoking task or situation was rated higher than fear of reinjury at both time points. This underscores the importance of individual responses, which may not be available from standardized patient-reported outcomes.

Fear of the knee giving way was included because it is commonly experienced at the time of ACL injury and is cited as a concern by patients before and after surgery.²⁶ Improvement in the fear of knee giving way, which demonstrated the largest effect size, might be related to expected improvements in knee stability after completion of a neuromuscular-focused return-to-sport training program. Similarly, fear of reinjury showed a large change magnitude after training, as many of the training exercises included jumping and cutting, which presumably were injury mechanisms. Clinically, if patients present with high levels of fear of knee instability or reinjury, intensive return-to-sport training may be used to address these impairments. Although fear of knee pain had the lowest intensity before training, it decreased after training and remained higher than fear of giving way after training, supporting previous claims that the fear-avoidance model is relevant to patients with ACL reconstruction.¹¹ However, because fear of knee pain showed the smallest magnitude of change, other treatments may be better suited to address fear of knee pain. Rarely has previous work assessed the intensity of psychologically focused questions,³ because fear of reinjury is most often represented as a binary variable.¹⁸ Querying specific fears and quantifying the change in intensity may be an important consideration when clinicians assess patients after specific treatments or as they progress toward return to sport.

Multiple patient-reported outcome questionnaires have been used to assess fear after ACLR. Recent clinical practice guidelines state that “clinicians may use the ACL-RSI...to assess psychological factors that may hinder return to sports before and after interventions intended to alleviate fear of reinjury associated with knee ligament sprain.”¹⁹ Other researchers have used the TSK-11 to

quantify fear.²⁴ Determining whether either can be used as a screen for fear of reinjury or individual fear-evoking task or situation would have good clinical utility. In our exploratory analysis, the ACL-RSI showed the ability to discriminate both fears at both pre- and posttraining assessment points. For example, if patients had high fear of reinjury, then they should be identified by a low (worse) total ACL-RSI score, which could then prompt the clinician to inquire further about specific tasks or situations that cause fear. Additionally, previous work has demonstrated that higher ACL-RSI scores improve the odds of returning to sport after ACLR²⁵ while pilot studies indicated that greater improvement in ACL-RSI²⁰ or lower TSK²⁴ scores are associated with lower risk of reinjury after resumption of sports participation. Conversely, the TSK-11 score discriminated only fear of reinjury intensity at pretraining and was not able to distinguish individual fear-evoking tasks or situations at either time point. TSK-11 scores have been reported to be higher (elevated kinesiophobia) in patients with ACLR who do not return to sport.^{7,15} It thus appears that kinesiophobia and fear of reinjury may both influence return to sport, but they are different psychological constructs requiring different assessment tools and possibly different interventions.

The strength of this study is that it represents a comprehensive assessment of injury-related fears before and after a return-to-sport training program. Past research mainly quantified whether patients perceived fear of reinjury (yes or no), and often rehabilitation interventions were not specified. The results of our study can help inform the development of a psychologically informed practice approach to address fear of reinjury in ACLR rehabilitation. Limitations of this study include the lack of a control group and a relatively small sample size. Because there was no control group, it is unknown how much of the change in ACL-relevant fears was due to the passage of time or exercise outside of the study. Also, because patients voluntarily chose to participate in the return-to-sport training program, a selection bias may have been present, as it is possible that the patients perceived decreased psychological function and thus felt the need to complete additional training. This study was performed with young athletes after ACLR, so findings may not be generalizable to older patients or those recovering from other surgical procedures. Last, the clinically meaningful change for a fear-evoking task on the scale used is unknown.

CONCLUSION

This study examined injury-related fears before and after a return-to-sport training program. The findings indicate that different tasks or situations evoke fear in different patients, that fear of reinjury and the specific fear-evoking task or situation may not be completely addressed through a return-to-sport program, and that the ACL-RSI has better potential than the TSK-11 to identify these fears during the return-to-sport period. These findings have implications for using a psychologically informed practice approach to address, in particular, fear of reinjury in ACLR

rehabilitation via use of the ACL-RSI to screen for fear of reinjury, asking patients to self-report activities that evoke fear, and using interventions in addition to neuromuscular exercise to address fear of reinjury.

ACKNOWLEDGMENT

The authors thank Jonny Diercks, MS, ATC, Craig Dorn, DPT, OCS, Layla Elmajri, DPT, OCS, Gregory Govrik, DPT, Rachel Hakanson, DPT, OCS, and Chad Kofoed, DPT, OCS, for their assistance with the training sessions. Part of this work was presented at the APTA Combined Sections Meeting in Washington, DC, in January 2019.

REFERENCES

- 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(7):601-614.
- Ardern CL, Taylor NF, Feller JA, Webster KE. A systematic review of the psychological factors associated with returning to sport following injury. *Br J Sports Med.* 2013;47(17):1120-1126.
- Ardern CL, Taylor NF, Feller JA, Webster KE. Fear of re-injury in people who have returned to sport following anterior cruciate ligament reconstruction surgery. *J Sci Med Sport.* 2012;15(6):488-495.
- Ardern CL, Taylor NF, Feller JA, Webster KE. Fifty-five per cent return to competitive sport following anterior cruciate ligament reconstruction surgery: an updated systematic review and meta-analysis including aspects of physical functioning and contextual factors. *Br J Sports Med.* 2014;48(21):1543-1552.
- 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(7):596-606.
- Chmielewski TL, George SZ, Tillman SM, et al. Low- versus high-intensity plyometric exercise during rehabilitation after anterior cruciate ligament reconstruction. *Am J Sports Med.* 2016;44(3):609-617.
- 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(12):746-753.
- Curl WW, Markey KL, Mitchell WA. Agility training following anterior cruciate ligament reconstruction. *Clin Orthop Relat Res.* 1983;(172):133-136.
- Flanigan DC, Everhart JS, Pedroza A, Smith T, Kaeding CC. Fear of reinjury (kinesiophobia) and persistent knee symptoms are common factors for lack of return to sport after anterior cruciate ligament reconstruction. *Arthroscopy.* 2013;29(8):1322-1329.
- Gagnier JJ, Shen Y, Huang H. Psychometric properties of patient-reported outcome measures for use in patients with anterior cruciate ligament injuries: a systematic review. *JBJS Rev.* 2018;6(4):e5.
- George SZ, Lentz TA, Zeppieri G, Lee D, Chmielewski TL. Analysis of shortened versions of the Tampa Scale for Kinesiophobia and Pain Catastrophizing Scale for patients after anterior cruciate ligament reconstruction. *Clin J Pain.* 2012;28(1):73-80.
- George SZ, Zeppieri G. Physical therapy utilization of graded exposure for patients with low back pain. *J Orthop Sports Phys Ther.* 2009;39(7):496-505.
- Gokeler A, Welling W, Zaffagnini S, Seil R, Padua D. Development of a test battery to enhance safe return to sports after anterior cruciate ligament reconstruction. *Knee Surg Sports Traumatol Arthrosc.* 2017;25(1):192-199.
- Hsu CJ, Meierbachtol A, George SZ, Chmielewski TL. Fear of reinjury in athletes. *Sports Health.* 2017;9(2):162-167.
- 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(5):393-397.
- Kvist J, Osterberg A, Gauffin H, Tagesson S, Webster K, Ardern C. Translation and measurement properties of the Swedish version of ACL-Return to Sports after Injury Questionnaire. *Scand J Med Sci Sports.* 2013;23(5):568-575.
- Leeuw M, Goossens ME, Linton SJ, Crombez G, Boersma K, Vlaeyen JW. The fear-avoidance model of musculoskeletal pain: current state of scientific evidence. *J Behav Med.* 2007;30(1):77-94.
- Lentz TA, Zeppieri G Jr, George SZ, et al. Comparison of physical impairment, functional, and psychosocial measures based on fear of reinjury/lack of confidence and return-to-sport status after ACL reconstruction. *Am J Sports Med.* 2015;43(2):345-353.
- Logerstedt DS, Scalzitti D, Risberg MA, et al. Knee stability and movement coordination impairments: knee ligament sprain revision 2017. *J Orthop Sports Phys Ther.* 2017;47(11):A1-A47.
- McPherson AL, Feller JA, Hewett TE, Webster KE. Smaller change in psychological readiness to return to sport is associated with second anterior cruciate ligament injury among younger patients. *Am J Sports Med.* 2019;47(5):1209-1215.
- Meierbachtol A, Yungtum W, Paur E, Bottoms J, Chmielewski TL. Psychological and functional readiness for sport following advanced group training in patients with anterior cruciate ligament reconstruction. *J Orthop Sports Phys Ther.* 2018;48(11):864-872.
- Myer GD, Chu DA, Brent JL, Hewett TE. Trunk and hip control neuromuscular training for the prevention of knee joint injury. *Clin Sports Med.* 2008;27(3):425-448, ix.
- Myer GD, Paterno MV, Ford KR, Quatman CE, Hewett TE. Rehabilitation after anterior cruciate ligament reconstruction: criteria-based progression through the return-to-sport phase. *J Orthop Sports Phys Ther.* 2006;36(6):385-402.
- Paterno MV, Flynn K, Thomas S, Schmitt LC. Self-reported fear predicts functional performance and second ACL injury after ACL reconstruction and return to sport: a pilot study. *Sports Health.* 2018;10(3):228-233.
- Sadeqi M, Klouche S, Bohu Y, Herman S, Lefevre N, Gerometta A. Progression of the psychological ACL-RSI score and return to sport after anterior cruciate ligament reconstruction: a prospective 2-year follow-up study from the French Prospective Anterior Cruciate Ligament Reconstruction Cohort Study (FAST). *Orthop J Sports Med.* 2018;6(12):2325967118812819.
- Tanner SM, Dainty KN, Marx RG, Kirkley A. Knee-specific quality-of-life instruments: which ones measure symptoms and disabilities most important to patients? *Am J Sports Med.* 2007;35(9):1450-1458.
- Vlaeyen JW, de Jong J, Geilen M, Heuts PH, van Breukelen G. The treatment of fear of movement/(re)injury in chronic low back pain: further evidence on the effectiveness of exposure in vivo. *Clin J Pain.* 2002;18(4):251-261.
- Vlaeyen JW, Linton SJ. Fear-avoidance and its consequences in chronic musculoskeletal pain: a state of the art. *Pain.* 2000;85(3):317-332.
- 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(1):9-15.
- 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(1-2):137-144.