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Original Research

The Influence of Mode-of-Injury on Psychological Readiness for Return-To-Sport Following Anterior Cruciate Ligament Reconstruction: A Matched-Controlled Study

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Background

Self-efficacy and fear of re-injury have been documented as factors related to an athlete's ability to return-to-sport after anterior cruciate ligament (ACL) reconstruction. The purpose of this study was to compare psychological readiness between athletes injured in their primary mode of sport versus those injured outside of their primary sport following ACL reconstruction.

Hypothesis

Athletes sustaining 'in-sport' injuries will demonstrate poorer psychological readiness when compared their matched counterparts injured outside of their primary sport.

Study Design

Case-Control Study

Methods

A single-surgeon database of 638 patients following ACL reconstruction was used to conduct a matched case-control analysis. Psychological readiness was examined 16-weeks postoperatively using the ACL-Return to Sport after Injury (ACL-RSI) questionnaire with subgroup analyses for the 'emotional', 'confidence' and 'injury-risk' subscales. Subject matching was performed for baseline patient and surgical demographics. All statistical comparisons were performed using a one-way (group) analysis variance (ANOVA) at a significance level of α = .05.

Results

Ninety-two matched patients (49 'in-sport' injuries, 43 'out-of-sport' injuries) were included in the final analysis. The 'in-sport' group exhibited significantly lower total ACL-RSI scores (55.3 ±12.9 versus 60.8 ±11.6, t = 2.747, P < .001) when compared to the 'out-of-sport' group. Subscale comparisons indicated lower 'emotional' (P < .016) and higher 'injury risk' (P < .001) psychological constructs for 'in-sport' athletes versus 'out-of-sport' athletes. No differences were found between groups for the 'confidence' subscale (P = .987).

Conclusions

Athletes sustaining 'in-sport' ACL injuries demonstrated poorer psychological readiness when compared to athletes injured outside their primary sport when in preparation for

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return-to-sport activities following ACL reconstruction.

Clinical Relevance

Clinicians should consider the potential impact of mode of injury on psychological readiness when returning athletes to sport after ACL reconstruction.

INTRODUCTION

There is an emerging body of evidence linking psychological factors to return-to-sport rates following ACL reconstruction.[1–5] Previous research has reported that 52% of high school athletes and 50% of collegiate athletes who underwent ACL reconstruction chose not to return-to-sport due to fear of re-injury.[6] These psychological factors also appear to have lasting consequences as athletes reporting a higher fear of reinjury display relatively lower return-to-sport rates for up to seven years following surgical reconstruction.[3,7,8] In contrast, athletes who successfully return to their preinjury level of participation often exhibit more positive responses to psychological outcome measures, including higher knee-related quality of life,[9] greater self-reported patient satisfaction,[10] and a lower fear-avoidance behaviors when compared to those who are unable to return to their preinjury participation level.[11,12] Furthermore, greater psychological readiness during rehabilitation has been shown to be a significant predictor of return to comparable level of performance.[13]

Prior studies have demonstrated that traumatic injuries often lead to altered psychological responses which negatively impact the recovery process.[3,9,14–18] The theory of contextual fear conditioning, also known as classical conditioning, states that a neutral stimulus can become conditioned when paired with an aversive unconditioned stimulus, such as pain.[19] When an injury occurs, the activity at the time of injury can become a conditioned stimulus to the individual, resulting in a heightened fear response. Behaviorists have developed models based on this theory in which classically conditioned fear acts as a driver that motivates and reinforces activity avoidance behaviors.[19] Based on this theory, patients participating in their respective sport at the time of injury would, theoretically, report a higher 'fear of re-injury' compared to those who were injured outside of their primary sport. For example, a collegiate soccer player who injures her ACL in soccer practice would potentially demonstrate an increased fear of re-injury when returning to soccer versus an American football player who sustains an ACL injury during a recreational basketball game. Unfortunately, no known clinical studies have been conducted to test this hypothesis in an ACL reconstruction population. Additionally, current literature suggests that psychological factors are potentially modifiable, and should be evaluated in athletes over time.[13] This recommendation was supported by the work of Ardern and colleagues which demonstrated that lower Anterior Cruciate Ligament-Return to Sport after Injury scale (ACL-RSI) scores assessed at 16-weeks following surgical reconstruction was a sensitive predictor for determining successful return to sport at 12-months.[11] Therefore, the purpose of this study was to determine whether athletes who sustain 'in-sport' ACL injuries exhibited poorer psychological readiness scores as assessed by the ACL-RSI scale when compared to matched subjects who sustain their injury outside their primary mode of sport following surgical reconstruction. The authors hypothesize that athletes who sustain an 'in-sport' ACL injury will display lower psychological readiness scores when compared to their 'out-of-sport' counterparts at 16-weeks following surgical reconstruction.

METHODS

STUDY DESIGN

A matched-case control study was conducted at the University of Texas Health Sciences Center examining a subset of patients enrolled within a larger prospective clinical trial. All eligible participants provided verbal and written consent that was approved by the University of Texas Health Sciences Center Institutional Review board. This study is registered at US National Institutes of Health (clinicaltrials.gov) as NCT # 03700996.

PARTICIPANTS

Recreational athletes with intentions of returning to their primary sport prior to undergoing ACL reconstruction were identified for study participation. Patients between 15 and 50 years of age were included if they received a unilateral ACL autograft reconstruction and regularly participated in level 1 or II sports (jumping, cutting, pivoting, and lateral movements) prior to surgery.[20] Those undergoing multiple ligament reconstruction, revision ACL reconstruction, ACL repair, or complex concomitant meniscus and/or chondral procedures that would delay weight-bearing were excluded from participation. Subjects were regarded as 'in-sport' if they reported sustaining their ACL injury while participating in their self-reported primary mode of sport and 'out-of-sport' if they reported their injury occurring outside of their reported primary mode of sport.

PSYCHOLOGICAL ASSESSMENT

Psychological readiness was assessed using the ACL-RSI at 16-weeks following ACL reconstruction.[21] This 12-item questionnaire evaluates three constructs of psychological involvement proposed to be associated with return-to-sport including confidence in performance, risk appraisal, and emotion. Previous studies have found the ACL-RSI scale to be valid, reliable, and predictive of return to preinjury level of sport following reconstruction surgery with a sensitivity of 0.97 and a specificity of 0.63.[10,22,23] The 16-week assessment period was selected based on the work by Ardern and colleagues who examined the relationship between ACL-RSI scores and return-to-sport rates, discovering that athletes who scored lower than 56 on ACL-RSI at 16-weeks following reconstruction were less likely to return-to-sport at 12-months.[10]

Table 1: Baseline Patient Demographics

	In-sport (n = 49)	Out-of-sport (n = 43)	P-Value
Age (yrs)	25.5 ±10.8	26.4 ±13.0	.561
Gender (%)	28 Males (57%)	26 Males (60.5%)	.740
BMI	24.6 ±4.1	25.2 ±5.3	.472
Graft Type (n, %) Bone Patellar-Tendon Bone Hamstring Quadriceps	 45 (91.8%) 3 (6.1%) 1 (2.0%)	 40 (88.6%) 2 (4.7%) 1 (2.3%)	.976
Meniscus Repair (n, %)	39 (79.6%)	35 (81.4%)	.984
MARX Scale (0-16)	10.7 ± 5.0	10.4 ± 5.2	.883
Data reported as mean ± standard deviation			

STATISTICAL ANALYSIS

Case matching was performed using age, gender, body mass index (BMI), and preinjury activity level as determined by MARX scale with the 'out-of-sport' participants serving as the reference group due to the relatively fewer numbers of participants.[24] Additionally, groups were matched by surgical characteristics including ACL graft type and frequency of meniscal involvement (e.g. meniscectomy/repair). Baseline patient demographics and surgical characteristics (graft type, meniscal injury) were analyzed using an independent *t*-test. Comparisons for ACL-RSI total scores and sub-scores between groups were analyzed using a univariate analysis of variance (ANOVA). An alpha level of .05 was selected to determine statistical significance, and IBM SPSS version 24 (Chicago, III, USA) was used for all statistical analyses.

RESULTS

From a cohort 638 patients undergoing ACL reconstruction, 187 met the inclusion criteria of the study, with 144 (29.3%) patients qualifying as an 'in-sport' injury and 43 (6.7%) patients sustaining 'out-of-sport' injuries (Figure 1). After patient matching the 'in-sport' contained 49 (7.7%) of similar age, gender and surgical profile (Table 1). A detailed list of activities in which patients had sustained their ACL injury is provided in Table 2.

Between-group differences at 16 weeks were observed for the 'out-of-sport' group demonstrating higher ACL-RSI scores (60.8 ±11.6 versus 55.3 ±12.4, t = 2.747, P < .001) when compared to the 'in-sport' group. Further analysis of the ACL-RSI subscales indicated that the 'out-of-sport' group demonstrated higher sub-scores on the 'emotional' (53.9 ±16.8 versus 45.9 ±17.2, t = 2.042, P < .016) and 'injury risk appraisal' (68.5 ±16.2 versus 61.3 ±14.7, t = 3.243, P < .001) subscales. There were no differences between groups for the 'confidence' subscale (63.2 ±11.6 versus 63.1 ±12.9, t = .018, P = .987) of the ACL-RSI.

DISCUSSION

The purpose of this study was to determine whether athletes who sustain 'in-sport' ACL injuries exhibited poorer psychological readiness when compared to matched controls who sustain their injury outside their primary mode of sport following surgical reconstruction at 16-weeks. In support of our hypothesis, the 'in-sport' group displayed lower ACL-RSI scores when compared to athletes who sustain their injury 'out-of-sport'. These results provide evidence to support the theory that 'mode of injury', specifically 'in-sport' injuries, can negatively impact psychological readiness scores at 16-weeks following ACL reconstruction.

The relationship between return-to-sport rates and the ACL-RSI has been well documented in previous studies.[10,14,22,25,26] These studies have reported that the ACL-RSI was an effective measure with regard to its discriminative capabilities for determining return-to-sport readiness.[22,26,27] Ardern and colleagues suggested that a score of less than 56 points when assessed at 16-weeks postoperatively was related to a higher likelihood of not returning to preinjury level of sport at 12 months and may help identify maladaptive psychological responses earlier in the recovery process.[10] The average ACL-RSI score for "in-sport" injured athletes (55.3±12.4) in our study fell below the cutoff score, indicating that particular attention to psychological recovery may be warranted for individuals in this group. Similar work by Langford and coworkers concluded that patients who were able to return to their preinjury level of competition had an average ACL-RSI score of 72 when assessed 12-months after surgery.[22] We recommend future investigators consider examining the differences between mode of injury at this timeframe to determine whether differences between groups persist out to a year. Regardless, when considering the link between low ACL-RSI scores and return-to-sport rates, clinicians should consider using strategies that enhance psychological readiness throughout all phases of rehabilitation.

The higher mean observed on the 'injury risk' subscale for 'in-sport' injuries was particularly interesting, and supports the theory of contextual fear conditioning.[19] These data may be useful for future investigators and psychologists interested in the development of effective intervention strategies to potentially mitigate these negative psychological responses. Theoretically, if the impact of these negative responses could be avoided, it may potentially en-

Table 2: Mechanism of Injury

Activity	In-Sport (n = 49)	Out-of-Sport (n = 43)
Football	13 (26.5)*	9 (20.9)
Basketball	7 (14.3)	3 (7.0)
Baseball/Softball	3 (6.1)	-
Soccer	10 (20.4)	3 (7.0)
Volleyball	3 (6.1)	3 (7.0)
Skiing/Snowboarding	1 (2.0)	10 (23.3)
Martial Arts	1 (2.0)	1 (2.3)
Running	1 (2.0)	2 (4.7)
Hockey	1 (2.0)	1 (2.3)
Rugby	1 (2.0)	-
Lacrosse	2 (4.1)	-
Dance	1 (2.0)	-
Badminton	1 (2.0)	-
Motocross	1 (2.0)	1 (2.3)
Trampoline	1 (2.0)	2 (4.7)
Field Events	2 (4.1)	1 (2.3)
Exercise	-	2 (4.7)
Bowling	-	1 (2.3)
Motor Vehicle Accident	-	1 (2.3)
Slip/Fall	-	3 (7.0)

**Data are presented as n (%)*

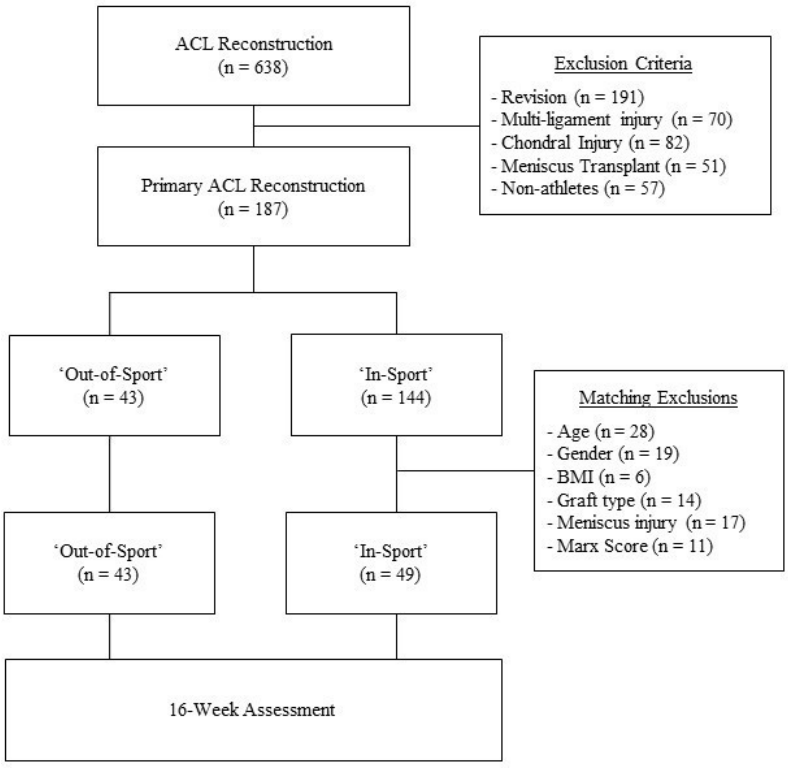

Figure 1: Study Design

hance the athletes' ability to return to their prior level of function; however, it is necessary to conduct these studies to confirm this hypothesis.

Considering that mode of injury may negatively influence the psychological profile of athletes, it is recommended to utilize the ACL-RSI to identify athletes subject to these deficits with the goal of implementing intervention strategies early within the rehabilitation process to mitigate the negative consequences of these injury mechanisms. While there is a paucity of research regarding the utilization of these interventions in an ACL population, previous studies have demonstrated their effectiveness in fear-avoidance behaviors found in patients with low back pain,[17,18,28–30] chronic disease,[29] musculoskeletal pain,[31] and knee osteoarthritis.[32] Beyond a psychological referral, rehabilitation professionals might consider utilizing techniques including education[33–35] to reduce fear-avoidance beliefs, health coaching,[17] quota-based exercise,[18] on-field rehab,[36] and exposure therapy.[28,29,37] Graded exposure involves progressive exposure to a hierarchy of situations or activities that cause fear for the purpose of showing that these activities can be completed without causing harm.[28,29,37] Della Villa et al. proposed the idea of incorporating on-field rehabilitation into the recovery process of an athlete returning to sport following ACL reconstruction.[36] Specifically, the authors recommend a progression from graded exposure in the clinical setting to an on-field setting in order to potentially address the environmental component of contextual fear conditioning. Caution should be used when considering these treatment recommendations as future research is warranted to examine the clinical effectiveness of these interventions for improving return-to-sport rates following ACL injury.

There are several limitations to this study which should be considered when examining these results. Previous studies have reported varying ACL-RSI cut-scores for predicting successful return-to-sport following reconstruction ranging from 56 to 76 based on the assessment timeframe.[22,23,38] In the current study, we selected a 16-week assessment not only based on the previous research, but also to serve as a pragmatic means of delivering treatment interventions to patients displaying poorer psychological readiness. However, this may be considered as a limitation as only one ACL-RSI score was used to evaluate the psychological profile of athletes along the athletes' entire continuum of care. It is recommended that future research be conducted to examine the differences between 'in-sport' and 'out-of-sport' injuries at the time of return-to-sport, and subsequently return to prior level of performance in order to validate these measures. Lastly, this sample only includes patients from a high-volume, single surgeon ACL database which may potentially limit the generalizability of these results.

CONCLUSION

Athletes who suffer ACL injuries within their primary sport exhibit poorer emotional psychological constructs, and higher self-reported injury-risk when compared to those injured outside of their primary sport following ACL reconstruction. Clinicians should consider the contextual factors involving 'mode of injury' when investigating psychological variables of injured athletes attempting to return-to-sport.

CONFLICT OF INTEREST

Dr. Walter Lowe, MD is a paid consultant for DonJoy Inc. & Arthrex Inc. Neither DonJoy Inc. or Arthrex Inc had involvement with any phase of this study.

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