Restorative Physical Function and Patient-Reported Outcomes After Acute Lateral Ankle Sprain in High School Athletes

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Context: Limited longitudinal data exist on patient-reported outcomes (PROs) after acute lateral ankle sprain (LAS). The impact of prospective hop testing on PROs at return to play (RTP) and 6 months post-RTP is unclear.

Objective: To determine if high school athletes with an LAS who return to baseline physical function as measured by a single-leg hop for distance (SLHOP) have better PROs relative to individuals who return to symmetry.

Design: Cohort study.

Setting: Ten high schools over 2 years.

Patients or Other Participants: Two hundred six high school athletes who sustained an LAS were included. Baseline SLHOP testing was completed preinjury. Patient-reported outcomes were recorded at time of injury, RTP, and 6 months post-RTP. Participants were classified as symmetry (n = 134) or restorative (n = 72). Symmetry was defined as achieving an SLHOP performance within 10% of the uninjured limb at RTP. Restorative was defined as achieving an SLHOP performance within 10% of preinjury levels.

Main Outcome Measure(s): The Foot and Ankle Ability Measure (FAAM)-Activities of Daily Living, FAAM-Sport, Patient-Reported Outcomes Measurement Information System (PROMIS) Anxiety, and PROMIS Depression were analyzed using a 2-way nonparametric analysis of variance. The interaction term of group by time was the main comparison of interest and was interpreted if significant. Post hoc multiple comparisons were performed using the Tukey-Kramer test.

Results: The restorative group reported better FAAM scores at RTP and 6 months post-RTP (P < .05) relative to the symmetry group. There were no differences in PROMIS Anxiety scores at time of injury, RTP, or 6 months post-RTP between groups (P > .05). There were no differences in PROMIS Depression scores at time of injury between groups (P = .34), but the restorative group had worse PROMIS Depression scores at RTP (P = .03).

Conclusions: The restorative group reported better FAAM-ADL and FAAM-Sport scores at RTP and 6 months post-RTP relative to the symmetry group. Restoring individuals to baseline physical function rather than limb symmetry may ensure better PROs after an LAS.

Key Words: symmetry, single-leg hop, FAAM, PROMIS

Key Points

- High school athletes restored to preinjury levels of physical function after a lateral ankle sprain (LAS) reported higher Foot and Ankle Ability Measure scores at return to play and 6 months post-return to play relative to the symmetry group.
- Baseline hop testing and the incorporation of patient-reported outcomes may be powerful tools to support clinical decision-making after LASs.
- Psychosocial measures of anxiety and depression may be helpful in monitoring athlete recovery after an LAS to assay other aspects of quality of life not measured by the Foot and Ankle Ability Measure.

Lateral ankle sprains (LASs) are one of the most common injuries sustained to the lower extremity in high school athletes, accounting for about 40% of all lower extremity injuries.¹ Although LASs do well with conservative care to minimize swelling and restore range of motion and therapeutic exercise to improve sensorimotor control, the recurrence of injury and development of chronic ankle instability (CAI) are high.^{2.3} Reportedly, many who sustain an acute LAS suffer from persistent deficits in ankle function and quality of life months to years after injury.³ Thus, appropriate return-to-play (RTP) testing criteria are needed to support clinical decisionmaking to improve patient-reported outcomes (PROs) after injury.⁴

Return-to-play testing after an LAS may include clinical tools such as PROs and functional hop testing. Although current clinical guidelines encourage the use of functional hop testing for RTP decision-making after an LAS,⁵ there is a lack of consensus regarding testing thresholds or which hop test to use.⁴ Traditional hop testing and measures of

strength after lower extremity injury typically use the contralateral limb as a healthy comparison; however, there is evidence to suggest achieving symmetry may not indicate restored sensorimotor function.⁶ Simon et al collected single-leg hop distance in high school athletes before lower extremity injury, including LAS, and found significant decreases in jump distance for both the injured and uninjured limbs with no change in symmetry index, indicating potential sensorimotor changes to both limbs and calling into question the validity of using the contralateral limb as a "healthy" comparison.⁶ In addition to objective measurements of sensorimotor dysfunction after injury, subjective measures may also be helpful in identifying individuals who appear physically recovered but may have underlying deficits determined by self-reported levels of function.

Patient-reported outcome measures can be used to assess a patient's perceived level of function or mental state after injury. Because LASs can affect both an athlete's physical and mental well-being,7,8 measuring PROs throughout recovery may help identify individuals below normative values who would benefit from additional recovery time. Valovich McLeod et al assessed health-related quality of life in adolescent athletes with a recent self-reported injury and found lower scores related to physical function, pain, and social and global functioning relative to uninjured controls.⁷ Furthermore, Simon et al studied changes in PROs of athletes after lower extremity injury in high schools with an athletic trainer (AT) and found significant improvements over time, although PROs at RTP were still below normative levels.8 Lam et al reported similar findings after an LAS, in which patients reported an improved Global Rating of Function at the RTP time point, but also reported a functional deficit (Global Rating of Function <100%) at RTP.⁹ The results of these studies may indicate that PROs in isolation are not enough to inform RTP decision-making, as deficits remain or are below normative levels after RTP. There is limited evidence describing PROs after acute LAS at multiple time points, and it is unknown how prospective hop testing may influence PROs at RTP or 6 months post-RTP. Therefore, the purpose of this study was to determine if individuals who return to baseline physical function (restorative) as measured by a single-leg hop for distance (SLHOP) have better PROs relative to individuals who return to symmetry in high school athletes who sustain a LAS. We hypothesized that the restorative group would have higher levels of self-reported measures of ankle function relative to the symmetry group.

METHODS

Participants

As part of a large prospective epidemiological study examining all lower extremity injuries, 206 high school athletes who sustained an LAS were analyzed for the current study. Participant demographics can be found in Table 1. An LAS was defined as requiring the player to miss at least 24 hours of sports participation and having been diagnosed by an AT. A standardized treatment or rehabilitation protocol was not implemented; however, the high schools' ATs were instructed to follow standard of care. Over the course of 2 years, participants were recruited from 10 high schools from the football, volleyball, girls' soccer, boys'

Table 1. Descriptive Statistics for Participant Demographics^a

	Symmetry $(n = 134)$	Restorative $(n = 72)$	<i>P</i> Value	Effect Size
Sex (M:F)	86:48	40:32		
Age, v	16 (2)	16 (1)	.08	-0.12
Height, cm	177.80 (15.24)	170.18 (14.61)	<.001 ^b	-0.29
Weight, kg	73 (29)	74 (13)	.06	-0.13
Time loss, d	6 (5)	6 (4)	.75	0.02
Severity				
Mild	119	61	_	_
Severe	15	11	_	_
Baseline SLHOP, cm				
Injured limb	179.33 (48.33)	178 (49.67)	.004 ^b	-0.20
Uninjured limb	182 (51.33)	181.17 (43.33)	.031 ^b	-0.15
RTP SLHOP, cm				
Injured limb	144.66 (39.01)	168.66 (46.42)	.002 ^b	0.22
Uninjured limb	155.42 (42.00)	178.17 (46)	<.001 ^b	0.32

Abbreviations: F, female; M, male; RTP, return to play; SLHOP, single-leg hop for distance.

^a Data are median (interquartile range); *P* values are nonparametric Mann-Whitney *U*. Severity: *mild*, ≤9 days; *severe*, ≥10 days.

^b Indicates significant Mann-Whitney U, P < .05.

soccer, girls' basketball, boys' basketball, wrestling, softball, baseball, and track and field teams. Participants were excluded from study enrollment if they had endured an injury within the last 6 months that required surgery or sustained an injury within the last month that withheld the athlete from competition or participation for more than a week. All participants signed an informed consent or assent document with a parent/guardian consent form that was approved by the university's institutional review board.

SLHOP

Individuals completed an SLHOP with 3 trials on each leg at preinjury (preseason testing) and RTP as part of the larger epidemiological study. The SLHOP was the sole functional measure collected for the larger study, as it was found to be the most time- and cost-efficient test. Participants were instructed to balance on 1 leg using their preferred starting limb, hop forward as far as possible, and land on the same limb. Hop trials alternated between limbs and were valid if the participant was able to "stick" their landing for at least 2 seconds with no additional hops or contralateral limb touchdown. The maximum hop distance of the 3 trials for each limb was used for data analysis at both time points (preinjury and RTP).⁶ Before data collection, participants received 2 practice trials. *Return to play* was defined as the return to full unrestricted sports participation.

Based on the SLHOP data from preinjury and RTP, participants were classified into 2 groups: symmetry or restorative. Symmetry was defined as obtaining an SLHOP performance within 10% of the uninjured limb at RTP. Restorative was defined as obtaining an SLHOP performance within 10% of preinjury levels. Individuals who were restorative and also achieved symmetry were defined as restorative. Participants were grouped retrospectively at the conclusion of the study to avoid potential influence over ATs' RTP decision-making. Some participants (n = 10) reached RTP without achieving SLHOP scores within

Patient-Reported Outcome Measures

Participants completed the Foot and Ankle Ability Measure (FAAM) and the Patient-Reported Outcomes Measurement Information System (PROMIS) Depression and Anxiety scales at time of injury (within 24 hours of injury), RTP (within 48 hours after RTP), and 6 months post-RTP (within 1 week of 6 months post-RTP).

The FAAM is a valid and reliable instrument consisting of a 21-item Activities of Daily Living (ADL) and 8-item Sport subscales that focuses on impairments of the leg, foot, and ankle.¹⁰ Each item is scored on a 5-point Likert scale in which 0 represents *unable to do* and 5 represents *no difficulty*, with global FAAM scores ranging from 0% to 100%.¹⁰ Higher scores on the FAAM indicate higher patient-perceived levels of function. The minimal clinically important difference (MCID) values for the FAAM-ADL and FAAM-Sport are 8 and 9, respectively.¹⁰

The PROMIS is a PRO measure that examines health status for physical, mental, and social well-being.^{11,12} Domains included for the current study were the PROMIS Anxiety (13 items) and PROMIS Depression (14 items) scales. Raw scores for the Anxiety subscale range from 13 to 65, and Depression scores range from 13 to 70. Higher scores on the PROMIS Anxiety and PROMIS Depression scales indicate higher self-perceived levels of anxiety and depression, respectively. For score interpretation, PROMIS Anxiety and PROMIS Depression scores as previously outlined and validated by Rothrock et al.¹³

Statistical Analysis

Descriptive statistics for participant demographics and SLHOP data were calculated as median (interquartile range) and analyzed for each group (restorative and symmetry) using nonparametric Mann-Whitney *U* tests (Table 1). Nonparametric effect sizes were calculated as Z/\sqrt{n} . Severity of current injury was estimated based on time loss and was broken into 2 categories: *mild* (\leq 9 days) and *severe* (\geq 10 days).¹⁴

The independent variables were group (restorative and symmetry) and time (time of injury, RTP, and 6 months post-RTP). The dependent variables were FAAM-ADL, FAAM-Sport, PROMIS Anxiety, and PROMIS Depression. The assumption of normality was violated for all 4 dependent variables as assessed by Shapiro-Wilk test. Thus, non-parametric testing was conducted. Data were analyzed using the aligned rank transform procedure.^{15,16} Subsequently, a 2-way nonparametric analysis of variance was conducted with type III sum-of-squares correction for the unbalanced samples.¹⁷ The interaction term of group by time was the main comparison of interest and was interpreted if significant. Post hoc multiple comparisons were performed using the Tukey-Kramer test if appropriate and effect size was calculated by $\eta^{2.18,19}$ Alpha was set at .05 for all analyses.

To describe change in MCID values of the FAAM-ADL and FAAM-Sport, the percentages of patients who had a meaningful clinical change between time of injury and RTP and between RTP and 6 months post-RTP were calculated. Patients were excluded if scores were within the MCID range of the maximum score (100) at time of injury or RTP (>92 on the FAAM-ADL and >91 on the FAAM-Sport), as it was not mathematically possible for them to achieve a clinically meaningful change.²⁰ Ultimately, 169 and 166 cases were included in the MCID results for the FAAM-ADL and FAAM-Sport at 6 months post-RTP. No cases were excluded at RTP.

Spearman ρ correlations were conducted to evaluate the relationships between FAAM-ADL, FAAM-Sport, PROMIS Anxiety, and PROMIS Depression scales at all time points (time of injury, RTP, and 6 months post-RTP). Correlation coefficients were considered *weak* (0.10–0.29), *moderate* (0.30–0.49), or *strong* (0.50–1.0). *P* values were corrected using the false discovery rate Benjamini-Hochberg procedure for multiple comparisons.²¹ Corrected *P* values less than .05 were considered significant.

Lastly, to explore the influence of group assignment on meeting recommended cutoff scores on the FAAM-ADL and FAAM-Sport subscales, χ^2 analyses were conducted at both RTP and 6 months post-RTP time points. Using established criteria from the International Ankle Consortium, cutoff scores were defined as ≥ 90 for FAAM-ADL and ≥ 80 for FAAM-Sport.²² Individuals falling below these values are consistent with patients with CAI.²²

RESULTS

There were statistically significant differences between groups for height, baseline SLHOP, and SLHOP at RTP; however, effect sizes for height, weight, and baseline SLHOP were small (d < 0.30) and considered not clinically significant. Of note, there was no significant difference in time loss between symmetry and restorative groups (P = .75). Descriptive statistics for each dependent variable by group and time are located in Table 2.

FAAM-ADL

The interaction of group by time was significant, $F_{2, 612} = 24.25$, P < .001, $\eta^2 = 0.09$. In the restorative group, pairwise comparisons of FAAM-ADL scores over time showed a statistically significant increase from time of injury to RTP (P < .001, d = 2.72), time of injury to 6 months post-RTP (P < .001, d = 3.84), and RTP to 6 months post-RTP (P < .001, d = 1.12).

In the symmetry group, pairwise comparisons for FAAM-ADL scores over time showed a statistically significant increase from time of injury to RTP (P < .001, d = 2.75) and time of injury to 6 months post-RTP (P < .001, d = 3.96), but not RTP to 6 months post-RTP (P = .35).

There was no significant difference in FAAM-ADL scores at time of injury between groups (P = .67). However, the restorative group had significantly higher FAAM-ADL scores at RTP (P < .001, d = 0.77) and 6 months post-RTP (P < .001, d = 0.76) than at time of injury. The results indicate that although both groups had a significant improvement in FAAM-ADL over time, the restorative group had greater improvement relative to the symmetry group at RTP and 6 months post-RTP.

Table 2. Descriptive Statistics for Patient-Reported Outcomes Measures (Group by Time)^a

	Time of		6 Months
	Injury	RTP	Post-RTP
FAAM-ADL			
Symmetry ^{b,c}	40 (20)	75 (16) ^d	86 (25) ^d
Restorative ^{b,c,e}	26 (16)	85 (10)	100 (2)
FAAM-Sport			
Symmetry ^{b,c}	19 (19)	70 (23) ^d	65 (5) ^d
Restorative ^{b,c,e}	22 (6)	80 (9)	100 (10)
PROMIS Anxiety			
Symmetry ^{b,c}	61.40 (23.20)	48.00 (3.80)	51.20 (5.70)
Restorative ^{b,c}	57.70 (15.40)	48.00 (5.70)	51.20 (5.70)
PROMIS Depression			
Symmetry ^b	51.80 (6.70)	49.00 (4.90) ^d	51.80 (4.90)
Restorative	51.80 (4.90)	51.80 (4.90)	53.90 (4.90)

Abbreviations: ADL, Activities of Daily Living subscale; FAAM, Foot and Ankle Ability Measure; PROMIS, Patient-Reported Outcomes Measurement Information System; RTP, return to play.

^a Data are median (interquartile range); PROMIS subscale scores are presented as T-scores.

^b Significant within-groups difference (time of injury to RTP).

- Significant within-groups difference (time of injury to 6 months post-RTP).
- ^d Significant between-groups difference (symmetry versus restorative).
- Significant within-groups difference (RTP to 6 months post-RTP).

FAAM-Sport

The interaction of group by time was significant, $F_{2,612} = 58.99$, P < .001, $\eta^2 = 0.16$. In the restorative group, pairwise comparisons of FAAM-Sport scores over time showed a statistically significant increase from time of injury to RTP (P < .001, d = 3.13), time of injury to 6 months post-RTP (P < .001, d = 3.06), and RTP to 6 months post-RTP (P = .001, d = 0.42).

For the symmetry group, pairwise comparisons for FAAM-Sport scores across the 3 time points showed a significant increase from time of injury to RTP (P < .001, d = 2.79) and time of injury to 6 months post-RTP (P < .001, d = 3.12), but not RTP to 6 months post-RTP (P = .56).

There was no significant difference in FAAM-Sport scores at time of injury between groups (P = .54). However, the restorative group had significantly higher FAAM-Sport scores at RTP (P < .001, d = 1.41) and 6 months post-RTP (P < .001, d = 1.45) than at time of injury. Again, although both groups had significant improvement in FAAM-Sport scores over time, the restorative group had greater improvement relative to the symmetry group, particularly at 6 months post-RTP. Of interest, the symmetry group experienced a decline in scores from RTP to 6 months post-RTP.

Clinically Meaningful Change for FAAM-ADL and FAAM-Sport

Table 3 describes the percentages of patients achieving the MCIDs for the FAAM-ADL and FAAM-Sport at RTP and 6 months post-RTP. The entire LAS cohort (100%) experienced a clinically meaningful change in FAAM scores from time of injury to RTP (Table 3). However, at 6 months post-RTP this number dropped to 77% and 39% for FAAM-ADL and FAAM-Sport, respectively. Furthermore,

Table 3. Numbers and Percentages of Participants Meeting MCID Scores

	FAAM-ADL, No. (%)		FAAM-Sport, No. (%)		
Group	RTP	6 Months RTP Post-RTP		6 Months Post-RTP	
LAS cohort	206 (100)	130/169 (76.90)	206 (100)	64/166 (38.60)	
Symmetry Restorative	134 (100) 72 (100)	72/111 (64.90) 58/58 (100)	134 (100) 72 (100)	17/108 (15.70) 47/58 (81.00)	

Abbreviations: ADL, Activities of Daily Living subscale; FAAM, Foot and Ankle Ability Measure; LAS, lateral ankle sprain; MCID, minimal clinically importance difference; RTP, return to play.

^a The MCID scores were defined as \geq 8 for the FAAM-ADL and \geq 9 for the FAAM-Sport. Return to play includes the change from time of injury to RTP. Six months post-RTP includes the change from RTP to 6 months post-RTP.

for the FAAM-Sport at 6 months post-RTP, 81% of the restorative group achieved MCID scores relative to 16% of the symmetry group.

PROMIS Anxiety

The interaction of group by time was not significant (P = .61); however, the main effect for time was significant ($F_{2,612} = 78.58$, P < .001, $\eta^2 = 0.12$). In the restorative group, pairwise comparisons for PROMIS Anxiety scores over time showed a statistically significant decrease (improvement in reported anxiety symptoms) from time of injury to RTP (P < .001, d = 1.13) and time of injury to 6 months post-RTP (P = .001, d = 0.68), but not RTP to 6 months post-RTP (P = .33).

For the symmetry group, pairwise comparisons for PROMIS Anxiety scores over time showed a statistically significant decrease from time of injury to RTP (P < .001, d = 1.29) and time of injury to 6 months post-RTP (P = .02, d = 0.75), but not RTP to 6 months post-RTP (P = .57).

There were no significant differences in PROMIS Anxiety scores at time of injury, RTP, or 6 months post-RTP when comparing restorative and symmetry groups (P >.05). For both the symmetry and restorative groups, the largest improvement in PROMIS Anxiety scores was seen from time of injury to RTP, with both groups reporting slightly worsening scores 6 months post-RTP.

PROMIS Depression

The interaction of group by time was significant, $F_{2, 612} = 12.91$, P < .001, $\eta^2 = 0.05$. For the restorative group, pairwise comparisons for PROMIS Depression scores over time showed a statistically significant increase (worsening reported symptoms of depression) from time of injury to 6 months post-RTP (P = .04, d = 0.39), with no significant differences between time of injury to RTP (P = .99) or RTP to 6 months post-RTP (P = .46).

For the symmetry group, pairwise comparisons for PROMIS Depression scores over time showed a statistically significant decrease (improvement in reported symptoms of depression) from time of injury to RTP (P = .04, d = 0.36), but not from time of injury to 6 months post-RTP (P = .56) or RTP to 6 months post-RTP (P = .20).

There were no significant differences in PROMIS Depression scores at time of injury between groups (P = .34).

Table 4. Correlations of Self-Reported Ankle Function and Psychological Outcomes^a

	PROMIS Anxiety		PROMIS Depression			
	Time of Injury	RTP	6 Months Post-RTP	Time of Injury	RTP	6 Months Post-RTP
FAAM-ADL						
Time of injury	-0.231ª	0.208 ^a	0.026	-0.040	-0.242 ^a	-0.159
RTP	-0.230^{a}	0.043	-0.252ª	-0.116	-0.110	-0.073
6 months post-RTP	-0.085	-0.115	0.006	-0.128	0.168 ^a	0.116
FAAM-Sport						
Time of injury	0.036	-0.188 ^a	0.198ª	-0.191 ^a	0.185 ^a	-0.108
RTP	-0.047	0.053	-0.224ª	-0.111	-0.013	0.060
6 months post-RTP	0.128	-0.118	-0.179ª	-0.052	0.173ª	0.046

Abbreviations: ADL, Activities of Daily Living subscale; FAAM, Foot and Ankle Ability Measure; PROMIS, Patient-Reported Outcomes Measurement Information System; RTP, return to play.

^a Indicates significant Spearman ρ correlation, *P* < .05, false discovery rate corrected.

However, the restorative group had significantly higher (worse) PROMIS Depression scores at RTP (P = .03, d = 0.33) but not at 6 months post-RTP (P = .77) when compared with the symmetry group. Similar to PROMIS Anxiety scores, both symmetry and restorative groups reported slightly worsening levels of self-perceived depression at 6 months post-RTP.

Correlations Between Self-Reported Ankle Function and Psychological Outcomes

Correlations of FAAM-ADL, FAAM-Sport, PROMIS Anxiety, and PROMIS Depression are located in Table 4. There were significant weak correlations between FAAM-ADL and PROMIS Anxiety, FAAM-ADL and PROMIS Depression, FAAM-Sport and PROMIS Anxiety, and FAAM-Sport and PROMIS Depression at various time points (Table 4).

Association of Group and Recommended FAAM Cutoff Scores

Four χ^2 tests for association were conducted between group (symmetry and restorative) and whether recommended cutoff scores were met on the FAAM-ADL and FAAM-Sport subscales at RTP and 6 months post-RTP. Counts and percentages of participants (per group) who met cutoff scores are located in Figures 1 and 2.

For FAAM-ADL at RTP, there was a statistically significant association between group and meeting cutoff scores, $\chi_1^2 = 14.72$, P < .001, $\phi = 0.27$. In the restorative group, 41.7% (n = 40) of individuals met the cutoff score of 90, whereas only 17.2% (n = 23) met the criteria in the symmetry group.

For FAAM-ADL at 6 months post-RTP, there was a statistically significant association between group and meeting cutoff scores, $\chi_1^2 = 104.42$, P < .001, $\phi = 0.71$. In the



Figure 1. The number of patients below and meeting recommended Foot and Ankle Ability Measure–Activities of Daily Living cutoff scores at return to play and 6 months post-return to play.



Figure 2. The number of patients below and meeting recommended Foot and Ankle Ability Measure–Sport cutoff scores at return to play and 6 months post-return to play.

restorative group, 100% (n = 72) met the cutoff score, whereas 25.4% (n = 34) met the criteria in the symmetry group.

For FAAM-Sport at RTP, there was a statistically significant association between group and meeting cutoff scores, $\chi_1^2 = 73.20$, P < .001, $\varphi = 0.60$. In the restorative group, 100% (n = 72) met the cutoff score of 90, whereas 38.8% (n = 52) of the symmetry group met cutoff criteria.

For FAAM-Sport at 6 months post-RTP, there was a statistically significant association between group and meeting cutoff scores, $\chi_1^2 = 193.33$, P < .001, $\varphi = 0.97$. In the restorative group, 100% (n = 72) met the cutoff score, whereas only 2.2% (n = 3) met the criteria in the symmetry group.

For all χ^2 analyses, there was a statistically significant association between being in the symmetry group and not meeting recommended cutoff scores on the FAAM-ADL and FAAM-Sport subscales at both RTP and 6 months post-RTP. All participants in the restorative group (n = 72) met recommended cutoff scores for all but the FAAM-ADL at RTP (n = 30; Figure 1).

DISCUSSION

To the best of our knowledge, this study is among the first to describe the differences in PROs across the span of injury and recovery after LAS. In line with our hypothesis, our results indicate that athletes who were restored to preinjury levels of physical function reported higher FAAM-ADL and FAAM-Sport scores at RTP and 6 months post-RTP relative to those who were returned to symmetry. These findings add to the growing body of literature that the use of the contralateral limb as a healthy comparison for functional testing after injury may not be the best indication of overall recovered function.

In recent years, the cascade of neurophysiological changes to both the injured and uninjured limbs after peripheral joint injury has become increasingly apparent.²³ Madsen et al examined limb symmetry using 5 different functional performance tests and compared these values between healthy controls and individuals with CAI.²⁴ Although there were no differences in interlimb symmetry between groups, the CAI group reported significantly higher perceived instability, potentially indicating a compensatory movement strategy to maintain physical performance.²⁴ These compensations seem to effectively mask underlying sensorimotor deficits despite achieving symmetry during functional testing.²⁴ Baseline or preinjury functional hop testing may be well suited to address the issue of contralateral limb changes after lower extremity joint injury. However, hop testing alone may not accurately assess sensorimotor function, as individuals may perform symmetrically but still report subjective measures of instability.²⁴ Current recommendations for RTP decision-making after LAS encourage both subjective and objective measures.⁵ Thus, the results of previous literature and our current findings support the combination of functional performance testing and measures of selfreported function as powerful tools to aid in the recovery of patients after injury.

In line with previous research, our LAS cohort exhibited lingering deficits or persistent disability in self-reported function at least 6 months after their injury (Table 2).²⁵ The median time loss for both the symmetry and restorative groups was about 6 days, which is comparable to findings of a previous study tracking LAS outcomes over time and provided enough time for all patients (100%) to achieve a meaningful clinical change (Table 3).²⁶ Authors of another study examining meaningful clinical change after an LAS reported that 86.5% and 85.2% of patients exceeded the MCID values for the FAAM-ADL and FAAM-Sport within

1 to 2 weeks postinjury.²⁰ Collectively, these data show the direct impact ATs have on managing LAS injuries in the short term. However, long-term function of these patients (6 months post-RTP) seems to suffer or decline (Tables 2) and 4). At RTP, 38.8% of the symmetry group met recommended cutoff scores on the FAAM-Sport, but at 6 months post-RTP those meeting cutoff dropped to only 2.2% (Figures 1 and 2), meaning about 98% of the symmetry group had similar scores to individuals with CAI.²² In another study examining lingering deficits after LAS at RTP, 58% of patients had scores <90% on the FAAM-ADL and 72% had scores < 80% on the FAAM-Sport.²⁶ A potential reason for the differences in percentages could stem from the time loss/days to RTP, as our patients' median time loss was about 6 days whereas the previous study reported about 13 days.²⁶ The restorative group fared significantly better, with 100% meeting recommended cutoff scores on both the FAAM-ADL and FAAM-Sport at 6 months post-RTP (Figures 1 and 2). Based on these data, the restorative group had more successful FAAM outcomes at 6 months post-RTP, whereas the symmetry group struggled to meet recommended cutoff criteria for FAAM-ADL and FAAM-Sport at RTP and 6 months post-RTP.

The observed decline in long-term function, especially in the symmetry group, highlights the clinical importance of continued focus on recovery even after RTP. Closing the gap on the last approximately 10% for full recovery may require targeted interventions that address specific challenges faced by patients during this phase (ie, instability, decreased range of motion, muscle weakness). Alternatively, the decline in long-term self-reported ankle function may also be an indicator of the structural damage occurring at the joint. Despite reports that complete ankle ligament healing occurs between 6 weeks and 3 months after injury,²⁷ our LAS cohort returned to play within about 6 days, potentially contributing to the decline in their long-term physical function.

One of the most interesting aspects of the current study is the grouping of symmetry and restorative athletes and its potential use for classification of individuals who may go on to develop CAI relative to those who become ankle copers. Although both groups saw improvements in selfreported ankle function over time, the symmetry group experienced a decrease in FAAM-Sport scores at 6 months post-RTP. Unlike the ADL subscale, the Sport subscale is specific to athletic activities such as running, jumping, and cutting or change of direction, which are activities that may provoke episodes of instability. Previous researchers established that reports of self-assessed/perception of disability are accurate diagnostic tools for CAI.²⁸ Although previous researchers have had varying reports on hop testing to classify individuals with CAI and copers, hop testing alone may not be sufficient at detecting differences between these 2 groups.²⁸

Another important aspect of the current study is the tracking of psychological PROs over time in those with an LAS. Both symmetry and restorative groups experienced mild to moderate anxiety and/or depression at some point from time of injury to 6 months post-RTP, with the highest levels of anxiety reported at time of injury (Table 2). There were no group differences in PROMIS Anxiety or Depression scores at time of injury. However, both groups reported a significant decrease in PROMIS Anxiety and Depression scores from time of injury to RTP. Previous

work by Simon et al reported similar results, with a decrease in PROMIS Anxiety scores from initial injury to RTP in high school athletes in schools with an AT.⁸ A current consensus statement regarding athlete mental health lists "psychological response to injury and illness" as a factor for clinicians to acknowledge when working with athletes.⁸ Thus, it is possible that the ATs at the sampled high schools effectively managed the psychosocial aspects of injury from initial onset to RTP. However, both symmetry and restorative groups reported slightly elevated levels of depression and anxiety at 6 months post-RTP relative to RTP. One potential explanation of these post-RTP results includes the end or conclusion of the regular sports season, as the link between physical activity and psychological well-being in adolescents is difficult to dispute.³⁰ A recent systematic review found that physical activity had a positive impact on quality of life and psychological well-being (anxiety, depression), so it is reasonable to believe the conclusion of the sports season may result in a dip in selfreported mental health.³⁰

Alternatively, another explanation for the drop in selfreported mental health may include the relationship between self-reported psychological outcomes and measures of selfreported ankle function (FAAM-ADL, FAAM-Sport) as reported in Table 4. For example, both FAAM-ADL and FAAM-Sport scores at RTP were negatively associated with PROMIS Anxiety scores at 6 months post-RTP, meaning that as FAAM scores decreased (worsened), PROMIS Anxiety increased (worsened). This negative trend was less evident for FAAM scores and PROMIS Depression at 6 months post-RTP. Many of the significant correlations reported in Table 4 would be considered weak, which emphasizes the importance of using PROs that assess different constructs. Patientreported outcomes commonly used by ATs typically encompass only 1 domain (ie, bodily structure/function), and recent studies have highlighted the importance of using a wholeperson approach (ie, patient-centered care using multiple PROs) to inform clinical decision-making.³¹

Limitations

This study is not without limitations, as we were unable to collect other injury data variables, such as CAI diagnosis or history or severity of previous LAS. These variables should be considered in future research directives in this patient population as it may contribute to long-term functional outcomes. Although there was no standardized rehabilitation protocol implemented, the ATs at the sampled schools were instructed to follow the current standard of care. To better identify the differences between restorative and symmetry groups, future authors may wish to implement a standardized protocol or track the athletic training services received by athletes after an LAS. Furthermore, only high schools with ATs were included, and thus the results of this study may not be generalizable to the population at large who sustain an LAS. Another limitation of the current study stems from the lack of PRO data regarding longer-term follow-up (>6 months) as well as reinjury rates between symmetry and restorative groups. Future research is needed to better understand the differences between symmetry and restorative groups and their response to lower extremity injury, specifically if other functional or neurophysiological differences exist. Further, the 10 individuals who did not achieve

functional symmetry or restorative definitions may be a population worth further investigation. Future researchers should also consider additional PROs to explore between symmetry and restorative groups, such as psychological readiness to return to sport, kinesiophobia, or a long-term assessment of health-related quality of life.

CONCLUSIONS

High school athletes who were restored to preinjury levels of physical function after LAS reported higher FAAM-ADL and FAAM-Sport scores at RTP and 6 months post-RTP relative to those who were returned to symmetry. Overall, the symmetry group struggled to meet recommended cutoff scores on the FAAM-ADL and FAAM-Sport subscales at both RTP and 6 months post-RTP, whereas 100% of the restorative group met recommendations at 6 months post-RTP. The results of this study support baseline hop testing and the incorporation of PROs to support clinical decisionmaking after an LAS. Additionally, psychosocial measures of anxiety and depression may be helpful in monitoring athlete recovery after an LAS.

ACKNOWLEDGMENTS

This study was fully funded by the National Athletic Trainers' Association Research & Education Foundation. We would also like to thank the participating high schools and athletic trainers who assisted in data collection.

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