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Original Research

Psychological Factors Change During the Rehabilitation of an Achilles Tendon Rupture: A Multicenter Prospective Cohort Study

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Abstract

Objective. The authors sought to gain insight into the changes in psychological factors during rehabilitation after Achilles tendon rupture (ATR) and to explore the association between psychological factors during rehabilitation and functional outcome 12 months after ATR.

Methods. Fifty patients clinically diagnosed with ATR were invited to visit the hospital 3, 6, and 12 months after injury for data collection. They completed questionnaires assessing psychological factors: psychological readiness to return to sport (Injury Psychological Readiness to Return to Sport Questionnaire); kinesiophobia (Tampa Scale for Kinesiophobia); expectations, motivation, and outcome measures related to symptoms and physical activity (Achilles Tendon Total Rupture Score); and sports participation and performance (Oslo Sports Trauma Research Centre Overuse Injury Questionnaire). To determine whether psychological factors changed over time, generalized estimating equation analyses were performed. Multivariate regression analyses were used to study the association between psychological factors at 3, 6, and 12 months and outcome measures at 12 months after ATR.

Results. Psychological readiness to return to sport improved, and kinesiophobia decreased significantly during rehabilitation. Psychological readiness at 6 and 12 months showed significant associations with sports participation and performance. Kinesiophobia at 6 months was significantly associated with symptoms and physical activity. Motivation remained high during rehabilitation and was highly associated with symptoms and physical activity, sports participation, and performance.

Conclusion. Psychological factors change during rehabilitation after ATR. Patients with lower motivation levels during rehabilitation, low psychological readiness to return to sports, and/or high levels of kinesiophobia at 6 months after ATR need to be identified.

Impact. According to these results, psychological factors can affect the rehabilitation of patients with ATR. Physical therapists can play an important role in recognizing patients with low motivation levels and low psychological readiness for return to sport and patients with high levels of kinesiophobia at 6 months post-ATR. Physical therapist interventions to enhance motivation and psychological readiness to return to sport and to reduce kinesiophobia need to be developed and studied in the post-ATR population.

Lay Summary. With Achilles tendon rupture, level of motivation, psychological readiness for return to sport, and fear of movement can affect rehabilitation outcome. A physical therapist can help recognize these factors.

Keywords: Psychology, Patient-Reported Outcome Measure (PROM), Motivation, Kinesiophobia, Confidence, Achilles Tendon Rupture

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Introduction

Achilles tendon rupture (ATR) is the most common tendon rupture in the human body.[1,2] Global incidence of ATR has steadily increased in recent decades, and approximately 70% of cases are sports related.[2–6] A peak incidence in people who are 40 to 49 years old of up to 80 per 100,000 person-years has been noted, probably as a result of increasing recreational sports activity by people who are middle-aged.[2–4,7] ATR is a severe injury, causing acute loss of function and long-term deficits. Limitations are seen in muscle strength, endurance, and function even 10 years after the initial injury.[8,9] Overall quality of life is significantly reduced, even at 12 months after injury.[10]

Despite the increasing incidence and major burden of ATR, consensus on ATR management is lacking,[11,12] and differences in outcome between operative and nonoperative treatment appear subtle.[13,14] Hence, methods of rehabilitation are potentially more important for recovery than the initial treatment.[15,16] The time to return to sports (RTS) is unpredictable and often exceeds 6 months.[11,15,17] Additionally, 20% of recreational athletes are not able to RTS at all.[17] In professional athletes, this rate is even worse: 30% retire after an ATR.[18] Early functional rehabilitation, such as weight-bearing and strength exercises, have been shown to be effective[15,19]; however, consistent rehabilitation guidelines are still lacking, potentially contributing to suboptimal rehabilitation outcomes.[15]

The importance of psychological aspects in rehabilitation after a sports injury is being increasingly acknowledged.[20–22] In a range of sports injuries, psychological factors have been identified as outcome predictors.[23–27] There is a gap in the literature regarding knowledge about whether psychological factors change during recovery from ATR and their role in relation to outcome. Research shows that RTS after injuries similar to ATR in either structure (tendinopathies) or injury mechanism (anterior cruciate ligament [ACL] ruptures) seems to be influenced by psychological factors. Mallows et al showed in their systematic review that psychological factors, such as kinesiophobia, catastrophizing, and distress, are associated with higher pain scores and extension of treatment in multiple tendinopathies.[26] Several psychological factors, such as fear, motivation, confidence, and self-efficacy, were related to outcome in several studies in patients with ACL rupture.[20,24,25,28–30] Ardern et al showed that psychological readiness was the factor most strongly associated with RTS after ACL rupture.[24] Knowledge about the role of psychological factors during rehabilitation in patients after ATR may ultimately lead to improved rehabilitation outcome.

The primary aim of the current study was to gain insight into the changes in psychological factors during the rehabilitation process after ATR. This study also aimed to explore associations between psychological factors during rehabilitation and functional outcomes 12 months after ATR.

Methods

Study Design

This multicenter prospective cohort study included patients treated for an ATR in 1 of the 3 largest hospitals in the northern areas of the Netherlands: University Medical Center Groningen, Martini Hospital Groningen, and Medical Center Leeuwarden. Ethical approval was obtained from the medical ethics review boards of University Medical Center Groningen (METc 2017/126), Martini Hospital Groningen (MEC 2017–087), and Medical Center Leeuwarden (COV 274(a)). This is part of a larger cohort study whose protocol has been described previously.[31]

Participants and Procedures

Eligible patients were adults (age ≥18 years at the time of inclusion) who were clinically diagnosed with ATR at the emergency department of 1 of the 3 hospitals between July 2017 and November 2018. Patients were included within the first 3 months after injury. Patients who were physically unable to perform the tests, unable to understand written Dutch, or cognitively unable to complete the questionnaires were excluded.

All participants received oral and written information about the study prior to giving written informed consent. Participants were invited to visit the hospital at 3 months (T1), 6 months (T2), and 12 months (T3) after injury for data collection, coordinated by an independent researcher (O.C.D.) who was not involved in their treatment or rehabilitation. Clinicians were not guided by researchers in the interventions provided. Table 1 displays an overview of the patient-reported outcome measures (PROMs), physical tests, and time of measurement.

Measurements

Participant Characteristics

A baseline questionnaire was constructed for specific use in this study. The questionnaire covered biographical information (age, sex), anthropometrics (height, weight), lifestyle factors (physical activity level, work), and personal and family medical history, including injury- and tendon-related symptoms, injury etiology and extent, and management factors during rehabilitation.

Questionnaires Assessing Psychological Factors

The Injury Psychological Readiness to Return to Sport Questionnaire (I-PRRS) assesses an athlete's psychological readiness to RTS after injury.[32] The Dutch language I-PRRS has shown to be valid and reliable.[33,34] The Tampa Scale for Kinesiophobia (TSK) measures fear of reinjury due to movement and physical activity.[35] The Dutch version, which is considered valid, was adapted for this study to be used for tendon injuries.[36] Expectations and motivation of participants regarding return to preinjury activity level were assessed with a 6-item questionnaire described by Sonneson et al.[30] The questionnaire was translated and adapted for this study (Tab. 2).

Questionnaires Assessing Function and Participation

The Achilles Tendon Total Rupture Score (ATRS) is a questionnaire designed to measure outcome related to symptoms and physical activity in patients after ATR treatment.[37] We used the Dutch version, which has been found to be valid, reliable, and responsive.[38,39] The 4-item Oslo Sports Trauma Research Centre Overuse Injury Questionnaire (OSTRC-O) is used to assess the consequences of injuries in sports participation and performance.[40] The OSTRC-O, although developed for overuse injuries but also applicable for acute injuries, is considered reliable and valid.[41–44] The Dutch version is slightly adapted for Achilles tendon injury by replacing "knee" with "Achilles tendon."[45]

Table 1. Measurements[a]

PROM/Physical Test	Time of Measurement (mo)	Construct	Items	Score Range	Interpretation
Demographic and lifestyle	3				N.A.
Psychological factors					
I-PRRS	3, 6, 12	Injured athletes' psychological readiness for and confidence in RTS participation	6 items, 100-point scale	0–60	60 = high confidence; 40 = moderate confidence; 20 = low confidence
TSK	3, 6, 12	Kinesiophobia, fear of reinjury due to movement and physical activity	17 items, 4-point scale	17–68	Higher scores = higher levels of kinesiophobia
Expectations/motivations questionnaire[b]	3 (6 and 12 only for motivation)	RTS expectations and motivation of athletes with Achilles tendon ruptures	Expectations: 8 items, score ranges differ by question[b]	Diverse[b]	
			Motivation: 3 items, 10-point scale	1–10/item	Higher scores = higher levels of motivation
Outcomes					
ATRS	3, 6, 12	Outcomes related to symptoms and physical activity	10 items, 11-point scale (0–10)	0–100	0 = no symptoms and full function/recovery; 100 = maximum disability
OSTRC-O	3, 6, 12	Consequences of injuries in sports participation and performance	4 items, 4- or 5-point scale (numerical value = 0–25)	0–100	0 = no problems in participation and performance
Reasons for no RTS	12	Rank the reasons for failed RTS	1	Order of rank	N.A.
Physical tests					
Heel-rise	12	Endurance	1 test/leg	Limb Symmetry Index[c]	The closer to 100%, the better
Single-leg hop	12	Function of entire lower extremity	3 tests/leg; mean distance hopped over the 3 repetitions	Limb Symmetry Index[c]	The closer to 100%, the better

[a]ATRS = Achilles Tendon Total Rupture Score; I-PRRS = Injury Psychological Readiness to Return to Sport Questionnaire; N.A. = not applicable; OSTRC-O = Oslo Sports Trauma Research Centre Overuse Injury Questionnaire; PROM = patient-reported outcome measure; RTS = return to sports; TSK = Tampa Scale for Kinesiophobia. [b]See Table 2. [c]The score of the non-dominant leg is expressed as a percentage of the score of the dominant leg.

Patients who reported that they had not returned to their preinjury sports activity were asked to rank the following reasons for not returning, from most important to least important: poor tendon function; do not trust the tendon; fear of reinjury; team or training has changed; family commitments; work commitments; fear of having to repeat rehabilitation; fear of not reaching the same level; fear of not meeting expectations of team, coaches, or family; fear of loss of income; and other reasons. This questionnaire was used in previous ACL injury research.[24] The scale has been translated to Dutch and modified for Achilles tendon injury.

Functional Physical Tests

The single-leg heel rise (HR) test was used to assess patient endurance by counting the number of HRs.[46] Patients were instructed to stand on 1 foot on an incline board and execute as many HRs as possible at a rate of 30 rises per minute, guided by a metronome.[47] The Limb Symmetry Index was calculated by dividing the score of the injured limb by the score of the uninjured limb and multiplying the result by 100 to obtain a percentage difference between the limbs. This test is a reliable measure of patient endurance after ATR.[46]

The single-leg hop (SLH) test for distance was used to measure function of the entire lower extremity.[48] Patients were instructed to stand on 1 leg and hop once as far forward as possible, landing only on the same leg. Each leg was tested 3 times, and the Limb Symmetry Index was calculated as the (mean score for the injured limb/the mean score for the uninjured limb) × 100.

Data Analysis

All statistical analyses were conducted with IBM SPSS Statistics for Windows software (version 26.0.0.1; IBM SPSS, Chicago, IL, USA). First, descriptive statistics were used for all data: means and SDs (or medians and interquartile ranges were calculated). All variables were checked for distribution. Statistical significance was set a priori at $P < .05$.

To determine if there was a significant difference in the PROM scores between 3 and 6 months and between 6 and 12 months, a generalized estimating equation analysis was performed, with exchangeable working correlation matrix. To gain more insight into the change in PROM scores over time, a graphical representation of the score development was constructed. Hence, if necessary, PROM scores were recoded to a score from 0 to 100, where 100 stands for the most positive result. PROMs were recoded only for the Supplementary Figure; for all the other statistical analyses, the original coding of data was used. To establish the association

Table 2. Questionnaire About Participants' Expectations and Motivation to Return to Preinjury Activity Level

Area	Question	Response Model	Time Point		
			3 mo	6 mo	12 mo
Expectations	1. Have you received information about the rehabilitation?	Yes/no/I don't know	×		
	2. Do you feel prepared for the rehabilitation?	1–10; not prepared at all–very well prepared	×		
	3. When do you think you have completed the rehabilitation?	Numbers of months	×		
	4. When do you think you can run on even ground	Numbers of months	×		
	5. When do you think you can jump on 1 leg?	Numbers of months	×		
	6. When do you think you can return to your earlier activity?	Numbers of months	×		
	7. What do you think is of importance for you to be able to reach your desired activity?	Choose the 2 most important factors: a good knee surgeon/a good physiotherapist/good compliance to rehabilitation/individual adjustments of the rehabilitation program/no unexpected incidents, eg, disease/other	×		
	8. Is your goal to return to your pre-injury activity and level?	Yes/no	×		
Motivation	1. How important is it for you to return to your pre-injury activity level?	1–10; not important at all–very important	×	×	×
	2. Do you think it is possible to return to your pre-injury activity level?	1–10; not possible–possible	×	×	×
	3. How much effort are you willing to make to return to your pre-injury activity level?	1–10; not willing at all–very willing	×	×	×

between psychological factors (I-PRRS, TSK, expectations, and motivation) at 3, 6, and 12 months after ATR and outcome measures at 12 months after ATR (ATRS, OSTRC-O, SLH, and HR), multivariate linear regression analyses were performed investigating the relationship between each individual factor and outcome measure, adjusted for potential confounders age, sex, primary treatment, and sports level. Furthermore, a multivariate model was constructed to study the associations between a change in scores (T3 – T1) of psychological factors (I-PRRS, TSK) and outcome measures (ATRS, OSTRC-O).

Role of the Funding Source

The funders played no role in the design, conduct, or reporting of this study.

Results

Sixty-four patients were assessed for eligibility, 14 of whom were excluded because they did not meet the inclusion criteria (n = 3), they declined to participate (n = 5), or it was not possible to contact the patient (n = 6). Thus, a total of 50 patients were included; 34 (68%) were men, with a mean age of 42.6 years and a mean body mass index of 25.5 kg/m^2 (Tab. 3). Most participants played sports at the recreational level (76%), and 44 (88%) of the ATRs occurred while playing sports. Surgery was performed on 14 participants (28%) as a primary treatment.

Course of Psychological and Functional PROMs After ATR

Questionnaires Assessing Psychological Factors

The scores on the I-PRRS and TSK were slightly above one-half of the maximum score at 3 months after ATR (Suppl. Figure). Scores on all questionnaires, except motivation, improved significantlybetween 3, 6, and 12 months after ATR ($P < .05$). Motivation scores were high from the start and did not change significantly over time (Tab. 4). At 3 months after ATR, almost all participants felt it was very important to return to their preinjury activity level and were willing to put a lot of effort into it (median score = 10).

Questionnaires Assessing Function and Participation

The ATRS increased the most between 3 and 6 months after ATR. Improvement of OSTRC-O scores occurred mainly after 6 months (Suppl. Figure). ATRS and OSTRC-O differed significantly between 3, 6, and 12 months ($P < .05$) (Tab. 3). After 12 months, 20 patients (40%) reported that they had not returned to their preinjury activity level. The 4 most important reasons for not returning to preinjury activity level were fear of reinjury (75%), poor tendon function (45%), fear of having to repeat rehabilitation (25%), and work commitments (20%). With regard to the functional tests, the Limb Symmetry Index of the HR test was 0.69 and that of the SLH test for distance was 0.93.

Association Between Psychological Factors and Functional Outcome After ATR

Multivariate linear regression analysis showed that especially higher motivation scores were negatively associated with OSTRC-O scores (sports participation and performance) at 12 months after ATR, corrected for age, sex, primary treatment, and preinjury sports activity level. TSK (kinesiophobia) scores measured at 6 months and expectation scores of the items for times to run on even ground and to jump on 1 leg were significantly associated with ATRS at 12 months after ATR. I-PRRS (psychological readiness and confidence to RTS) scores at 6 and 12 months after ATR were significantly associated with OSTRC-O results at 12 months after ATR (Tab. 5). Psychological factors were not associated

Table 3. Patient Characteristics[a]

Characteristic (N = 50)	Value
Sex	
Men	34 (68)
Women	16 (32)
Age, y, mean (SD)	42.6 (12.3)
Height, cm, mean (SD)	179.6 (11.6)
BMI, kg/m^2, mean (SD)	25.5 (3.2)
Preinjury sports activity	
Cyclic	11 (22)
Acyclic	21 (42)
Cyclic and acyclic	13 (26)
None	5 (10)
Preinjury sports activity level	
Recreational	38 (76)
Regional	5 (10)
(Inter)national	2 (4)
None	5 (10)
Sport time/wk, h, mean (SD)	4.4 (4.9)
Occupational activity	
Sedentary work	25 (50)
Dynamic physical work	13 (26)
Both	9 (18)
None	3 (6)
Prior tendon problems	
Yes	17 (34)
No	33 (66)
Activity at the time of rupture	
Ball sports	30 (60)
Racket sports	8 (16)
Other sports	6 (12)
Trauma during daily activities	4 (8)
Other	2 (4)
Primary treatment	
Operative	14 (28)
Nonoperative	36 (72)
Referred for physical therapy[b]	
Yes	43 (86)
No	7 (14)
Complications in first 3 mo	
Rerupture	3 (6)
Nerve damage (sural nerve)	3 (6)
Wound infection	2 (4)
Deep-vein thrombosis	1 (2)

[a]Data are reported as number (percentage) of patients unless otherwise indicated. BMI = body mass index. [b]Median number of physical therapy sessions in the first year after Achilles tendon rupture = 24.5 (interquartile range = 35.3).

with the Limb Symmetry Index for the SLH test or for the HR test (Suppl. Table). The changes in I-PRRS and TSK scores between 3 and 12 months after ATR were associated with a change in ATRS (Tab. 6).

Expectations

At 3 months after injury, 31 participants (62%) reported having received information on rehabilitation, and 28 participants (56%) felt prepared for the rehabilitation (scores = 6–10), with a mean score for all participants of 5.5 out of 10 (SD = 2.9). At that time point, participants expected to be able to run on even ground after 8.2 (SD = 2.4) months, jump on 1 leg after 9.1 (SD = 3.1) months, and complete their rehabilitation after a mean of 9.4 (SD = 2.7) months. Participants stated that a good physical therapist (88%), good compliance with rehabilitation (52%), and individual adjustments of the rehabilitation program (22%) were the most important factors in reaching their desired goal.

Discussion

The primary aim of the current study was to gain insight into the changes in psychological factors during the rehabilitation process after ATR. Secondarily, this study also aimed to explore associations between psychological factors during rehabilitation and functional outcomes 12 months after ATR. The results showed that psychological readiness and confidence to RTS increased over time and kinesiophobia decreased over time while motivation levels remained high. In particular, high motivation during rehabilitation resulted in more sports participation and performance 12 months after ATR. Furthermore, psychological readiness and confidence at 6 and 12 months after ATR had significantly positive associations with sports participation and performance at 12 months, and less kinesiophobia at 6 months after injury was significantly associated with better Achilles tendon function at 12 months.

Course of Psychological Factors and Associations With Function and Participation

Because of limited research in the ATR field, our results are compared with those of ACL rupture studies when no ATR studies are available, despite differences in mechanical function and demographic factors. For instance, patients with an ACL reconstruction (ACLR) are generally younger (20–29 years old) and have a more active lifestyle.[49]

Our study showed that psychological readiness to RTS increased and kinesiophobia decreased significantly over time. These findings are in line with the results of the ACLR study of Langford et al[25]; they also showed a decrease in psychological responses, as measured with the Emotional Response of Athletes to Injury Questionnaire, which assesses pressure, fear, motivation, stress, and other emotions. The negative emotions during the first months following the injury may be attributed to the consequences of the injury or surgery. During the mid-rehabilitation period (3–7 months), goals and visible progress are realized, which may explain a decrease in negative emotion. By contrast, Morrey et al[50] found an increase in mood disturbance and fear on receiving medical clearance for athletes with an ACL injury, which might be explained by their inclusion of both professional and recreational athletes, whereas the current study mostly examined recreational athletes. Professional athletes may have more fear than recreational athletes that they will not be able to perform at preinjury levels.[51]

The improvement in psychological readiness and confidence to RTS during ATR rehabilitation is significant and of clinical importance, because these changes (5 points between 3 and 6 months and 10 points between 6 and 12 months, as measured with the I-PRRS) are greater than the previously reported measurement error and minimally important change.[33] More psychological readiness and confidence in RTS at 12 months after ATR was associated with better self-reported symptoms and function, which is in line with a cross-sectional study on athletes who underwent ACLR and had been cleared to RTS.[52] Psychological readiness and confidence at 6 and 12 months after ATR had significantly positive associations with sports participation and performance at 12 months. This is consistent with findings that confidence to RTS was a strong predictive parameter for RTS when measured 6 months after ACLR.[25,53,54] In addition, changes in I-PRRS and TSK scores between 3 and 12 months after ATR were associated with changes in ATRS; for example, an

Table 4. Changes in Psychological and Functional PROM Scores at 3, 6, and 12 Months after ATR and Results of GEE Analysis[a]

Variable	Median Score (IQR) at T1[b]	Median Score (IQR) at T2[b]	Median Score (IQR) at T3[b]	*P*[c]	T1–T2				T2–T3			
					B	95% Wald CI		*P*	B	95% Wald CI		*P*
						Lower	Upper			Lower	Upper	
I-PRRS	40.0 (23)	45.0 (24)	55.0 (13)	<.001	7.2	2.1	12.3	.01	8.1	4.1	12.1	<.001
TSK	35.0 (8)	31.0 (7)	27.5 (6)	<.001	−3.7	−5.2	−2.1	<.001	−2.5	−4.2	−0.8	<.001
Motivation 1[d]	10.0 (1)	10.0 (2)	10.0 (1)	.17	−0.3	−0.6	0.1	.10	0.0	−0.3	0.3	.93
Motivation 2[d]	9.0 (2)	9.0 (2)	9.0 (2)	.89	0.1	−0.5	0.6	.77	−0.1	−0.6	0.4	.69
Motivation 3[d]	10.0 (1)	10.0 (1)	10.0 (1)	.15	−0.3	−0.6	0.0	.1	0.0	−0.3	0.3	.97
ATRS	67.0 (26)	38.0 (36)	12.5 (21)	<.001	−23.9	−29.7	−18.1	<.001	−22.0	−26.7	−17.4	<.001
OSTRC-O	83.0 (18.5)	64.0 (59.3)	6.0 (33.0)	<.001	−24.8	−34.0	−15.7	<.001	−34.3	−45.8	−22.8	<.001

[a]ATR = Achilles tendon rupture; ATRS = Achilles Tendon Total Rupture Score; B = non-standardized regression coefficient; GEE = generalized estimating equation; I-PRRS = Injury Psychological Readiness to Return to Sport Questionnaire; IQR = interquartile range; OSTRC-O = Oslo Sports Trauma Research Centre Overuse Injury Questionnaire; PROM = patient-reported outcome measure; TSK = Tampa Scale for Kinesiophobia. [b]T1 presents 3 months after ATR; T2 presents 6 months after ATR; T3 presents 12 months after ATR. [c]*P* value for GEE used to test significance of overall change in time. [d]Motivation 1 presents how important it is to return to your preinjury activity level; motivation 2 presents possibility of returning to your preinjury activity level; motivation 3 presents willingness to make the effort to return to your preinjury activity level.

Table 5. Multivariate Linear Regression Analyses of Psychological Factors and Achilles Tendon Function and Participation Level[a]

Independent Variable[b]	ATRS at T3				OSTRC-O at T3			
	B	Standardized ß Coefficient	95% CI	*P*[c]	B	Standardized ß Coefficient	95% CI	*P*[c]
I-PRRS at T1	−0.09	−0.09	−0.44 to 0.25	.59	−0.23	−0.16	−0.73 to 0.28	0.36
I-PRRS at T2	−0.31	−0.27	−0.75 to 0.14	.17	−0.88	−0.52	−1.48 to −0.28	**.01**
I-PRRS at T3	−0.56	−0.40	−1.00 to −0.12	**.01**	−1.52	−0.76	−2.01 to −1.02	**<.001**
TSK at T1	0.06	0.02	−1.02 to 1.13	.91	−0.22	−0.05	−2.01 to 1.57	.81
TSK at T2	1.28	0.43	0.31 to 2.25	**.01**	1.35	0.28	−0.43 to 3.14	.13
TSK at T3	0.51	0.19	−0.37 to 1.38	.25	0.45	0.11	−1.00 to 1.89	.54
Motivation 1 (possibility) at T1	−4.28	−0.34	−8.48 to −0.09	**.05**	−11.60	−0.66	−17.08 to −6.13	**<.001**
Motivation 1 (possibility) at T2	−0.50	−0.04	−4.55 to 3.54	.80	−9.68	−0.62	−14.45 to −4.91	**<.001**
Motivation 1 (possibility) at T3	−2.28	−0.21	−5.78 to 1.21	.19	−10.43	−0.71	−14.34 to −6.52	**<.001**
Motivation 2 (importance) at T1	−2.53	−0.24	−5.93 to 0.87	.14	−4.89	−0.33	−9.93 to 0.14	.06
Motivation 2 (importance) at T2	−2.39	−0.29	−5.11 to 0.34	.08	−7.73	−0.66	−11.00 to −4.46	**<.001**
Motivation 2 (importance) at T3	−3.82	−0.49	−6.03 to −1.60	**.00**	−8.10	−0.74	−10.76 to −5.45	**<.001**
Motivation 3 (effort) at T1	−0.07	−0.00	−7.00 to 6.86	.98	−17.23	−0.64	−26.02 to −8.45	**<.001**
Motivation 3 (effort) at T2	1.42	0.12	−2.78 to 5.62	.50	−7.19	−0.43	−12.91 to −1.47	**.02**
Motivation 3 (effort) at T3	0.91	0.07	−3.30 to 5.11	.67	−11.47	−0.65	−16.55 to −6.38	**<.001**
Expectation 2	−0.01	−0.01	−0.22 to 0.21	.95	−0.22	−0.25	−0.55 to 0.10	.17
Expectation 3	0.30	0.05	−2.12 to 2.72	.80	1.76	0.19	−2.16 to 5.69	.37
Expectation 4	2.74	0.37	0.30 to 5.17	**.03**	−0.94	−0.09	−4.94 to 3.06	.64
Expectation 5	2.19	0.37	0.23 to 4.15	**.03**	−0.81	−0.10	−3.97 to 2.34	.60
Expectation 6	1.20	0.18	−1.16 to 3.57	.31	2.17	0.23	−1.53 to 5.88	.24

[a]Confounding factors used were age, sex, primary treatment option, and preinjury sports activity level. ATRS = Achilles Tendon Total Rupture Score; B = non-standardized regression coefficient; I-PRRS = Injury Psychological Readiness to Return to Sport Questionnaire; OSTRC-O = Oslo Sports Trauma Research Centre Overuse Injury Questionnaire; TSK = Tampa Scale for Kinesiophobia. [b]T1 presents 3 months after Achilles tendon rupture (ATR); T2 presents 6 months after ATR; T3 presents 12 months after ATR. Motivation 1 presents possibility of returning to preinjury activity level; motivation 2 presents importance of returning to preinjury activity level; motivation 3 presents willingness to make the effort to return to preinjury activity level. For an explanation of expectations 2–6, see Table 2. [c]Bold type indicates a significant result.

I-PRRS improvement of 10 points resulted in a decrease of 3 points in the ATRS (= improvement). Psychological readiness for and confidence in RTS therefore appear to be related to the outcome.

Although the overall kinesiophobia level after ATR can be considered to be moderate—given that TSK scores above 37 are generally considered high[36,55–57]—less kinesiophobia at 6 months after injury was significantly associated with better Achilles tendon function at 12 months and showed a nonsignificant although substantially positive effect on participation level. The results of our longitudinal study are in accordance with those of a cross-sectional study 3 months after

Table 6. Multivariate Linear Regression Analyses of Changes in Psychological Factors and Achilles Tendon Function and Participation Level[a]

Independent Variable[b]	ATRS at T3 – ATRS at T1				OSTRC-O at T3 – OSTRC-O at T1			
	B	Standardized ß Coefficient	95% CI	*P*[c]	B	Standardized ß Coefficient	95% CI	*P*[c]
I-PRRS at T3 – I-PRRS at T1	−0.30	−0.34	−0.59 to −0.01	**.05**	−0.45	−0.34	−0.92 to 0.03	.06
TSK at T3 – TSK at T1	1.15	0.48	0.36 to 1.94	**.01**	0.28	0.08	−1.16 to 1.72	.70

[a]Confounding factors used were age, sex, primary treatment option, and preinjury sports activity level. ATRS = Achilles Tendon Total Rupture Score; B = nonstandardized regression coefficient; I-PRRS = Injury Psychological Readiness to Return to Sport Questionnaire; OSTRC-O = Oslo Sports Trauma Research Centre Overuse Injury Questionnaire; TSK = Tampa Scale for Kinesiophobia. [b]T1 presents 3 months after ATR; T3 presents 12 months after ATR. [c]Bold type indicates a significant result.

ATR demonstrating significant correlations between kinesiophobia and physical activity, patient-reported symptoms, and general health.[58] The fact that the association is also present over time implies for clinicians that an intervention to decrease kinesiophobia in those scoring above 37 during the first 6 months will likely have a positive effect in the long-term (at least 1 year) outcome of ATR. This idea is supported by a case series study of patients with Achilles tendinopathy 5 years after initiation of treatment in which it was concluded that increased kinesiophobia might have a negative effect on the effectiveness of exercise treatment.[59] The same results were seen in previous ACLR research reporting that lower levels of kinesiophobia were associated with higher functional outcome scores.[60,61]

Although reported motivation levels were high throughout rehabilitation, interventions such as setting short- and long-term rehabilitation goals could be beneficial for patients with slightly lower motivation levels to enhance motivation and adherence to rehabilitation exercises.[51] Physical therapists can play an important role in recognizing and motivating patients as they progress through rehabilitation.

Strikingly, psychological factors were associated with ATRS and OSTRC-O but not with the physical tests. A potential explanation for this finding is that the constructs measured with the PROMs and the physical tests are different. The ATRS and OSTRC-O measure outcome related to symptoms and physical activity and whether individuals participate in sports again, but these methods do not measure the function of the entire lower extremity or the strength and endurance of the plantar flexors as measured with the SLH test and the HR test. Psychological factors seem to have a particular influence on outcome related to activity and participation level (measured with ATRS and OSTRC-O) and less at the physical function level as measured with the SLH test and the HR test.

Interventions Need to Be Developed and Studied

The results of this study underscore that patients with low psychological readiness and confidence to RTS and lower motivation levels and patients with high levels of kinesiophobia at 6 months after ATR need to be identified. In addition, fear for reinjury and fear for having to repeat rehabilitation are important reasons for patients not returning to the preinjury activity level. Physical therapeutic as well as psychological interventions, such as relaxation or imagery, can be considered, yet there is limited and conflicting evidence on their effectiveness during rehabilitation of patients with sports injuries.[62,63] Given the expanding evidence on the influence of psychological factors during rehabilitation, interventions aiming to address these factors should be developed and future research on this topic is warranted.

Patients consider good follow-up treatment important, stating that a good physical therapist and compliance with rehabilitation were the most important factors for their ability to reach their desired sports activity level. With respect to healthy aging, people who are middle-aged are specifically encouraged to participate in exercise. We therefore argue for adequate guidance toward sports participation, especially among patients with ATR and lower levels of psychological readiness for and confidence in RTS and patients with high levels of kinesiophobia at 6 months after ATR.

Need for Effective Patient Education and Communication

This study highlights the importance of communication between health care provider and patient, patient education, and adequate rehabilitation. A large portion of the participants (38%) reported 3 months after ATR that they had not received information about their rehabilitation. The present study found limited associations between expectations and self-reported tendon symptoms and function and no associations with participation and performance. Additional information and discussion with the care provider about realistic expectations and rehabilitation are advised.

Strengths and Limitations

To the best of our knowledge, this is the first study whose primary aim is to investigate role of psychological factors in patients after ATR. Data were collected at 3 different time points during rehabilitation, and associations with function and participation were explored. Limitations include lack of a baseline measurement shortly after injury. Although the sample size was relatively small, the characteristics of the study population are in line with the description of the ATR population in the literature: the "weekend warrior," a middle-aged man who participates in athletic endeavors only on an occasional basis and who is at the greatest risk for rupture.[2,64] Other potential variables may have influenced the results. Multivariate linear regression analyses were corrected for the potential confounders age, sex, primary treatment, and sports activity level but not for body mass index and complications. The number of participants included in the study was too small to allow for more variables to be included in the model. In addition, a larger sample size as well as inclusion of baseline data shortly after injury in future studies will also allow

to incorporate more sophisticated analytical approaches (eg, mediation analysis).

Another limitation is that the validity of some of the (modified) questionnaires used has not yet been investigated in the Achilles tendon injury population. Other psychological factors (eg, anxiety, depression, self-efficacy) could also play a role in ATR patients and should be further explored. Qualitative research that includes semi-structured interviews may be appropriate to gain more insight into the presence of and changes in psychological factors.

Psychological factors change during rehabilitation after ATR. Psychological readiness and confidence to RTS improved and kinesiophobia decreased between 3, 6, and 12 months after ATR. Motivation scores remained evenly high over this time. Patients with low motivation levels during rehabilitation, low psychological readiness, and confidence to RTS and/or high levels of kinesiophobia at 6 months after ATR need to be recognized. Physical therapeutic and psychological interventions to enhance motivation and psychological readiness to RTS and to reduce kinesiophobia need to be developed and studied.

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Ethics Approval

Ethical approval was obtained from the medical ethics review boards of University Medical Center Groningen (METc 2017/126), Martini Hospital Groningen (MEC 2017–087), and Medical Center Leeuwarden (COV 274(a)).

Disclosures

The authors completed the ICMJE Form for Disclosure of Potential Conflicts of Interest and reported no conflicts of interest.

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