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ORIGINAL RESEARCH

Putting the fear-avoidance model into practice — what can patients with chronic low back pain learn from patients with Achilles tendinopathy and vice versa?

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KEYWORDS
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Abstract
Background: Fear-avoidance variables are present in patients with musculoskeletal pain conditions, such as chronic low back pain (CLBP) and Achilles tendinopathy (AT) and can lead to reduced function and recovery. It is unknown how these variables relate in populations with different etiologies but similar pain provocation mechanisms.
Objective: To compare kinesiophobia, pain catastrophizing, and disability between these two groups.
Methods: Patients with CLBP and those with AT were included. Tampa Scale of Kinesiophobia (TSK-17) and Pain Catastrophizing Scale (PCS-13) were evaluated in both groups. The CLBP group completed the Oswestry Disability Index (ODI) and the AT group completed the PROMIS-29 questionnaire. Gait speed was calculated for each group. Disability outcomes were normalized between groups.
Results: 119 patients in the CLBP group (64 female, 46 ± 8 years) and 83 patients in the AT group (42 female, 48 ± 12 years) were included. Both groups (CLBP, AT) presented with high prevalence of kinesiophobia (67%, 55%) but the CLBP group presented with higher prevalence of pain catastrophizing (22%, 2%). The CLBP group demonstrated higher levels of disability via normalized ODI (MD= 12.4, 95% CI: 9.2, 15.5) but the AT group demonstrated slower gait speed (MD= 0.1 m/s, 95% CI: 0.0, 0.2).
Conclusion: Similarly high prevalence of kinesiophobia was found in patients with CLBP and patients with AT. While the CLBP group reported greater prevalence of catastrophizing thoughts and greater disability, the AT group had slower gait speed. Overall, these findings demonstrate

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that CLBP and AT have similarities that may allow clinicians to learn from one to inform treatment of the other.
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Introduction

Chronic pain is a leading cause of disability globally and is associated with enormous health-care costs. For some time now, we have learned to understand chronic pain as a complex perceptual experience that involves sensory, affective, and cognitive components.[1,2] Affective factors, particularly fear, have proven to be central to the explanation and understanding of persistent pain.[3,4]

Chronic pain is by definition to have had pain for more than three months. Low back pain has a prevalence of 40–85% in a lifetime,[5] and 65% of individuals still report pain one year after their first incident.[6] Therefore, chronic low back pain (CLBP) is often used as an explanatory model for all chronic pain conditions. While Achilles tendinopathy (AT) has not frequently been categorized as a chronic pain condition, the injury fits some of the chronic pain criteria. Achilles tendinopathy is an overuse injury with a prevalence of 11.83 per 1000 person-years in the adult population with an average age of 30–55 years old.[7,8] This is a painful injury with symptoms and functional impairments often lasting for months to years.[9–11] Both athletes and sedentary individuals can develop AT and it often occurs when there is an increase in activity of daily living or sports activities.[7,12]

The Fear-avoidance model (FAM) is not one but several theoretical models that describe how psychological factors affect the experience of pain, and the development of chronic pain and disability.[3] The most well renowned FAM is the cognitive-behavioral fear avoidance model by Vlaeyen et al.,[3] which describes the transition of an acute injury to chronic through a progressing and then maintaining pattern of catastrophizing, fear, and avoidance followed by disuse, disability, and depression.[3] Extensive research has demonstrated a robust relationship between psychological factors and disability with the majority of studies performed on patients with CLBP.[13,14] Kinesiophobia (irrational fear of movement) is present in up to 70% and pain catastrophizing is present in up to 65% of patients with CLBP.[13,15] Pain related fear factors result in lower levels of physical activity, and thus more pain and disability in patients with CLBP.[16,17] Further, those with high fear avoidance beliefs demonstrate worse outcomes than those with low fear avoidance beliefs, indicating a significant need to address these psychological factors during treatment.[18–21]

Compared to patients with CLBP, there is less robust data regarding the association between AT and psychological factors such as kinesiophobia and pain catastrophizing. High degree of kinesiophobia has been reported in 38% of patients with AT with more recent data reporting moderate to high kinesiophobia in 72% of patients with AT.[22,23] As with CLBP, kinesiophobia has been associated with a higher degree of symptoms and disability as well as worse recovery of function in patients with AT.[24–27] There is inconclusive evidence for pain catastrophizing in patients with AT. While Chimenti et al.[28] reported a significant difference between patients with AT and a control group in pain catastrophizing,[28] another study reported no differences between groups.[29] However, the mean value of pain catastrophizing in the groups with AT in both studies was below the clinically meaningful level of catastrophizing.[30,31]

Despite CLBP and AT having different pain locations and different etiologies, chronic musculoskeletal pain conditions are thought to behave similarly according to the FAM.[3,14,21] Both injuries also have a movement based pain provocation but benefit from exercise and movement based interventions, thus fear avoidance behaviors need to be considered as it may relate to adherence.[23,32–35] Given these similarities, further comparison of these conditions may be beneficial in improving our general understanding of chronic pain conditions and may provide added insight into the use of the FAM on other conditions and/or the effect of other conditions on model variables. Additionally, as limited data exist regarding the relationship between kinesiophobia and disability in patients with AT, comparing psychological factors and objective measures of disability in this group with patients with CLBP may improve understanding of the impact of fear avoidance behaviors on disability. Therefore, the primary purpose of this study was to compare the prevalence of kinesiophobia and pain catastrophizing in patients with CLBP and patients with AT. Secondarily, we aimed to compare measures of disability among the two groups.

Methods

Study design

The patients involved in this cross-sectional analysis were recruited as part of two previous randomized controlled trials (NCT03523325, ISRCTN17115599) and completed informed consent procedures. Patients with CLBP were recruited as a part of a completed larger prehabilitation randomized control trial (ISRCTN17115599) for patients diagnosed with degenerative disk disease preceding lumbar fusion surgery. They were recruited from two spine clinics and one university hospital. All data were collected between April 2014 and June 2017 in Gothenburg, Sweden. The data used for this study are baseline data, before the prehabilitation intervention started. Original study protocols were reviewed and approved by the Regional Ethical Committee of Gothenburg. Patients with AT were recruited as a part of a larger ongoing longitudinal study (NCT03523325) investigating differences between men and women in an exercise program over the course of 1 year collected beginning in July 2018 and is ongoing in Newark, Delaware, USA. The data used for this study are baseline data, before the rehabilitation intervention started. Original study protocols were reviewed and approved by the University of Delaware

institutional review board. The two groups will be referred to as CLBP group and AT group.

Inclusion/exclusion criteria

To be included in the CLBP group, patients were required to be between the ages of 18 and 70 and have 1) a primary complaint of low back pain with degenerative changes in 1−3 segments of the lumbar spine, 2) additional minor radiating symptoms, 3) reproducible pain in relevant segment(s) at clinical examination, 4) had pain for at least 6 months and have undergone conservative treatment, and 5) surgery scheduled for lumbar fusion. Patients were excluded from the study if they had any of the following: 1) previous decompression surgery for spinal stenosis, 2) spinal malignancy, 3) dominating radiculopathy, 4) confirmed neurological or rheumatic disorder, 5) deformities in the thoracolumbar spine (eg. idiopathic scoliosis), or 6) poor understanding of Swedish.

To be included in the AT group, patients were required to be between the ages of 18 and 65 years and have a diagnosis of midportion AT based on the accepted diagnostic criteria and assessed by an experience therapist and/or physician.[36] Patients were excluded if they had a previous Achilles tendon rupture or had another injury limiting their ability to perform exercises on the injured limb.

Patient reported outcome measures

The Tampa Scale of Kinesiophobia-17 (TSK) was used to quantify kinesiophobia.[37] This self-assessment questionnaire contains 17 items with total scores ranging from 17 to 68 points. Greater scores indicate greater levels of kinesiophobia with a total score of $\geq$37 points indicating a high level of kinesiophobia. This cutoff score has been previously used in populations with chronic musculoskeletal pain to differentiate high and low levels of kinesiophobia.[4,37] The Swedish version (TSK-SV) was used for the CLBP group. The TSK-SV has been shown to be a reliable and valid measure for patients with chronic pain.[37]

The Pain Catastrophizing Scale (PCS) was used to quantify pain catastrophizing. This self-assessment questionnaire has 13 items with total scores ranging from 0 to 52 points.[30] Higher scores indicate greater pain catastrophizing with $\geq$30 points representing a clinically relevant level of catastrophizing.[38] The PCS contains high internal consistency, and is a reliable and valid tool for the measurement of pain catastrophizing.[39,40]

The Oswestry Disability Index (ODI) version 2.0 was used to assess disability of the CLBP group.[41] This questionnaire has 10 dimensions with total scores rated as a percentage from 0 to 100%.[41] Greater scores in this measure relate to greater levels of disability. The ODI has been shown to be a reliable and valid tool for measurement of disability in patients with CLBP.[42]

The Patient-Reported Outcome Measurements Information System (PROMIS-29) was used to assess disability of the AT group.[43] This questionnaire assesses function and well-being via 7 domains including physical function, fatigue, pain interference, depressive symptoms, anxiety, ability to participate in social roles and activities, and sleep disturbance.[43] The PROMIS-29 has been shown to be a valid and reliable measure for the assessment of disability[43] and can be used to predict nonoperative treatment success in patients with AT.[44]

Gait speed

The 10 meter walk test (10MWT) was performed for the AT group and 5 min walk test (5MWT) was performed for the CLBP group to assess disability.[45] In each measure, the patients were instructed to walk at their normal pace. Gait speed was assessed from each test.

Normalization of measures

As this was a retrospective comparison from two different studies, different patient reported outcomes measures for disability were used for the two groups and therefore, normalization was required prior to comparing the groups. Pennings et al.[46] suggested an equation for converting PROMIS-29 score to an equivalent ODI score, with a high reported correlation (r = 0.88) between predicted and actual ODI.[46] The equation reported below includes 6 PROMIS-29 domains: Physical Function (PF), Pain Intensity (PAIN), Sleep Disturbance (SD), Participation in social Roles (SR), Pain Interference (PI), and Depression (DEP).

$$ODI\% = 37.847 - 1.475 * [PF_{raw}] + 1.842 * [PAIN_{raw}] + 0.557 * [SD_{raw}] - 0.642 * [SR_{raw}] + 0.478 * [PI_{raw}] + 0.295 * [DEP_{raw}]$$

Results from the 5MWT in the CLBP group were transformed into gait speed to compare with the 10MWT from the AT group. Normalization for average gait speed was performed using Gait speed (m/s) = 5MWT/300. Normalized values of disability and gait speed were used for reporting and comparison of this study.

Statistical analysis

All data were analyzed using IBM SPSS Statistics (version 26.0, SPSS, Chicago, Illinois). The outcome variables of interest included demographics, patient related outcome measures, and gait speed. For demographics, mean difference (MD) or difference in proportion (DP) with its 95% confidence interval (CI) were calculated. All data are represented with mean and standard deviation (SD). All statistical analyses were performed using a significance level of $p \leq 0.05$. Sample sizes were reported for each outcome variable due to missing data.

A chi-square test was used to compare frequencies of TSK scores $\geq$37 and PCS scores $\geq$30, values indicative of clinical relevance, between the two groups. Independent t-tests were used to compare differences between the AT and CLBP groups for patient reported outcomes (TKS, PCS, and ODI) and gait speed.

Missing data

Missing 10MWT values existed due to lack of gait speed equipment for the first 12 patients in the AT group. A sensitivity analysis was performed using independent t-tests to determine if differences existed between those patients and

Table 1 Demographics of chronic low back pain and Achilles tendinopathy groups.

	CLBP group (n = 119)	AT group (n = 83)	Between-group difference (95 % Confidence Interval)
Sex			
Women	64 (54%)	42 (50%)	0.0 [−0.1, 0.2]
Age (years)	45.6 (8.4)	48.1 (11.9)	−2.5 (−5.4, 0.6)
Height (cm)	174.2 (9.2)	172.0 (8.6)	2.2 (−0.4, 4.6)
Weight (kg)	79.9 (14.7)	83.5 (17.4)	−3.6 (−8.0, 0.9)
BMI (kg/m^2)	26.3 (3.7)	28.1 (5.2)	−1.8 (−3.2, −0.6)

AT, Achilles tendinopathy; CLBP, chronic low back pain.
Data are mean (standard deviation), frequency (proportion), mean difference (95% confidence interval) or difference in proportion [95% confidence interval].

the remaining patients in demographics or other outcome measures.

Results

Group characteristics

A total of 202 patients were included in this study (119 patients with CLBP and 83 patients with AT; Table 1). There were no significant differences between the groups except for body mass index (BMI); MD= −1.8 kg/m^2, 95% CI: −3.2, −0.6, with the AT group demonstrating a greater BMI (mean ± standard deviation: 28.1 ± 5.2 kg/m^2) than the CLBP group (26.3 ± 3.7 kg/m^2).

Patient reported outcome measures

Fifty five of the 83 (67%) patients in the AT group and 64 of the 119 (55%) patients of the CLBP group had high level of kinesiophobia (TSK≥37) (Table 2). There was not a significant difference (DP= −0.1, 95% CI: −0.3, 0.0) between the two groups regarding percentage of patients within each group with high levels of kinesiophobia (Table 2). Further, no significant differences in TSK score were observed between the AT group and the CLBP group (Table 3). However, both

Table 2 Cut-off values for Tampa Scale of Kinesiophobia and Pain Catastrophyzing Scale.

	CLBP group (n = 119)	AT group (n = 83)	Between-group difference [95% Confidence Interval]
TSK			
$n \geq 37$	64 (54.7%)	55 (67.1%)	−0.1 [−0.3, 0.0]
$n \leq 36$	53 (45.3%)	27 (32.9%)	
PCS			
$n \geq 30$	26 (21.8%)	2 (2.4%)	0.2 [0.1, 0.3]
$n \leq 29$	93 (78.2%)	81 (97.6%)	

AT, Achilles tendinopathy; CLBP, chronic low back pain; PCS, Pain Catastrophizing Scale; TSK, Tampa Scale of Kinesiophobia.
Data are frequency (proportion) or difference in proportion [95% confidence interval].

Table 3 Comparison of outcome measures between chronic low back pain and Achilles tendinopathy groups.

	CLBP group (n = 119)	AT group (n = 83)	Between-group difference (95% Confidence Interval)
TSK	38.3 (8.5)	38.4 (5.5)	−0.1 (−2.1, 1.9)
	Missing	n = 2	n = 1
PCS	22.9 (8.2)	7.1 (7.9)	15.8 (13.5, 18.1)
	Missing	n = 0	n = 0
ODI	37.2 (12.7)	24.8 (9.4)*	12.4 (9.2, 15.5)
	Missing	n = 4	n = 0
Gait Speed (m/s)	1.39 (0.29)	1.29 (0.19)	0.1 (0.0, 0.2)
	Missing	n = 1	n = 12

AT, Achilles tendinopathy; CLBP, chronic low back pain; Gait Speed, Average Gait Speed; ODI, Oswestry Disability Index; PCS, Pain Catastrophizing Scale; TSK, Tampa Scale of Kinesiophobia.
Data are mean (standard deviation) or mean difference (95% confidence interval).
* normalized values.

Table 4 Sensitivity analysis of missing gait data in the Achilles tendinopathy group.

	AT group Missing Gait (n = 12)	AT group Valid Gait (n = 71)	Between-group difference (95% Confidence Interval)
Sex			
Women	8 (67%)	34 (48%)	0.2 [−0.1, 0.4]
Age (years)	52.2 (10.3)	47.4 (12.1)	4.8 (−2.5, 12.2)
BMI (kg/m^2)	28.1 (6.0)	28.1 (5.1)	0.0 (−3.3. 3.2)
TSK	37.3 (5.4)	38.6 (5.6)	−1.3 (−4.7, 2.2)
PCS	8.5 (6.7)	6.9 (8.1)	1.6 (−3.3, 6.6)
ODI	29.5 (9.5)*	24.1 (9.2)*	5.4 (−0.3, 11.2)

AT, Achilles tendinopathy; CLBP, chronic low back pain; ODI, Oswestry Disability Index; PCS, Pain Catastrophizing Scale; TSK, Tampa Scale of Kinesiophobia.
Data are mean (standard deviation), frequency (proportion), mean difference (95% confidence interval) or difference in proportion [95% confidence interval].
* normalized values.

groups presented with high levels of kinesiophobia (AT group, 38.4 ± 5.5; CLBP group, 38.3 ± 8.5).

The number of patients with high pain catastrophizing (PCS≥30) was significantly different between the groups (DP= 0.2, 95% CI: 0.1, 0.3) with 26 of the 119 (22%) patients of the CLBP group compared to only 2 of the 83 (2%) patients in the AT group. The CLBP group demonstrated significantly greater pain catastrophizing (MD= 15.8, 95% CI: 13.5, 18.1) than the AT group (Table 3). However, the means for both groups were below the clinically relevant level (≥30).

The CLBP group demonstrated significantly greater self-reported disability (MD= 12.4, 95% CI: 9.2, 15.5) as assessed via the normalized ODI than the AT group (Table 3). Both groups however, demonstrated mean scores indicative of moderate disability (21−40%).

Gait speed

The AT group demonstrated a significantly slower walking speed (MD= 0.1, 95% CI: 0.0, 0.2) than the CLBP group. Sensitivity analysis showed that the 12 missing data points from the AT group had no significant differences from the entire AT group in demographics (Table 4). Further, there were no significant differences in TSK, PCS, and normalized ODI between the missing patients and the remaining patients of the AT group.

Discussion

While both groups demonstrated similarly high prevalence of kinesiophobia, the CLBP group demonstrated greater prevalence of pain catastrophizing than the AT group. The AT group demonstrated a slower gait speed compared to the CLBP group, but the CLBP group had worse self-reported disability.

The AT group and the CLBP group both demonstrated high prevalence of kinesiophobia. Two prior studies reported a 38% prevalence of high levels of kinesiophobia in patients with AT.[22,24] However, this study reports a much greater prevalence of 67%, more similar to a broader group with exercise induced lower limb pain and a group with musculoskeletal pain.[4,47] Given the relationship between kinesiophobia and disability, these results demonstrate the need for clinicians treating patients with AT to be aware of the potential for kinesiophobia in this patient group.

While high levels of kinesiophobia were observed in both groups, pain catastrophizing was not as prevalent in either of the two groups. However, the CLBP group did demonstrate greater prevalence of high pain catastrophizing than the AT group. Only 22% of the CLBP group and only 2% of the AT group scored in the clinically relevant pain catastrophizing range. Previous studies investigating prevalence of pain catastrophizing in patients with low back pain reported up to 65% of the population with clinically relevant scores.[13] While this value is significantly greater than the 22% found in this study, the cutoff score on the PCS used in that study was 24 points compared to 30 points that was used for this study. Another study using 30 points as a cutoff for high catastrophizing reported 34.5% of patients with low back pain demonstrated high pain catastrophizing, more comparable to the results found in our study.[48] The value in patients with AT is consistent to a previous report noting no patients scoring above the clinically relevant pain catastrophizing threshold of 30 points.[29] Another study reported baseline mean PCS score in patients with AT at 12.6 points.[28] While this value is below the threshold for clinical relevance, it was significantly different than the control group.

These findings indicate that while high levels of kinesiophobia are present in both patients with AT and patients with CLBP, pain catastrophizing may not be as prevalent in those with AT. This seems to oppose the Fear avoidance model in that it posits that pain catastrophizing leads to pain-related fear. However, recent reviews of this model offer an expanded model that includes several factors that contribute to or help protect from kinesiophobia including pain intensity and pain resilience, in addition to pain catastrophizing.[49] Additionally, as a cross sectional study, we are unable to determine the development nor sequence of affective factors. However, these findings may suggest that other factors may lead to the development or presence of kinesiophobia other than just pain catastrophizing. Alternatively, the questionnaires used to assess pain catastrophizing and kinesiophobia may address different aspects of the injury experience. Achilles tendinopathy is associated with pain with loading activities and typically, there is minimal pain at rest.[50] Kinesiophobia is a fear associated with movement, a predominant component of AT. However, pain

catastrophizing may relate more to thoughts at rest, a time in which patients with AT typically don't experience as much pain. These differences between the psychological factors may explain why patients with AT demonstrate high levels of kinesiophobia but not pain catastrophizing.

The CLBP group also demonstrated greater disability as per the normalized ODI than the AT group. However, both the CLBP group and the AT group scores indicate a moderate level of disability with mean values between 21 and 40%. As the CLBP group was scheduled for surgery, it is not surprising though, that their self-reported disability was higher than the AT group. Walking speed has been deemed the "6th vital sign" in that it can help indicate an individual's general health.[51,52] Additionally, walking speed can help predict outcomes such as rehabilitation response and mobility disability.[51,53,54] Although the CLBP group demonstrated worse self-reported disability as determined through the normalized ODI, the AT group demonstrated a slower gait speed. While these values were calculated from different tests (10MWT for the AT group and 5MWT for the CLBP group), previous studies indicate the six minute walk test and 10MWT are highly correlated but the 10MWT gait speeds were generally faster.[55,56] This further emphasizes the difference in gait speeds between the two groups, although both groups had gait speeds within normative reference values.[57] However, as AT directly affects the foot/ankle, it may not be surprising that this injury is more directly influences walking than CLBP.

The similarities regarding affective factors between patients with CLBP and AT may allow for expansion of treatment philosophies across different body regions. For example, a comprehensive tendon loading program including pain monitoring and training diaries has been effective in treatment of AT.[58] Use of the pain monitoring model and training diaries may serve as a useful adjunct to the treatment of CLBP. Similarly, aerobic exercise has been an effective addition in the treatment of CLBP, and its use in the treatment of AT may need to be investigated. Considering the use of effective strategies from other conditions may be beneficial for optimizing treatment outcomes in chronic musculoskeletal pain conditions in general.

Limitations

This study contains several limitations. First, it has a cross-sectional design which limits the possibility to draw conclusions about how the various variables are related in time, that is, what actually leads to the other. Second, disability and gait speed were measured differently between groups and despite normalization, they may reflect slightly different constructs. Additionally, the CLBP group was awaiting surgery while the AT group was involved in an exercise-based treatment intervention. These differences in treatments may affect the patient's motivation and/or perception of their injury.

Conclusions

Kinesiophobia was similarly prevalent in patients with CLBP and patients with AT with over half of the patients in each group presenting with clinically significant levels of kinesiophobia. While the CLBP group reported greater prevalence of catastrophizing thoughts and greater disability, the AT group had slower gait speed. Overall, these findings demonstrate that patients with CLBP and AT demonstrate similarities in fear avoidance factors that may allow clinicians to learn from one to inform the treatment of the other.

Conflicts of interest

The authors declare no conflicts of interest.

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