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Exercise is Effective for Disease Activity Control with Various Effects on Entheses: An Ultrasound-Based Study

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SUMMARY

Introduction. The effect of physical activity on disease activity and enthesitis in patients with spondyloarthritis is unknown. We aimed to describe clinical and enthesis features and disease activity of spondyloarthritis patients and to assess the association between physical activity and disease activity.

Methods. We conducted a cross-sectional study including consecutive patients followed for radiographic axial spondyloarthritis. For each patient, we performed ultrasonography of entheses and assessed disease activity. Physical activity level was assessed using the University of California and Los Angeles (UCLA) activity scale and the Tegner activity scale.

Results. We examined 518 entheses in 37 patients. There were 29 men (78%) and 8 women (22%). The mean age was 44.62 ± 12.31 years. Exercise was performed in 51% of patients. The median (IQR 25%-75%) UCLA activity scale was 4 (4-5) and the median (IQR 25%-75%) Tegner physical activity scale was 3 (3-5). Exercise was associated with a lower risk of disease activity (OR 0.123, p = 0.022, 95%CI 0.020-0.742). We didn't find a significant difference in enthesis ultrasound characteristics between the patients practicing or not practicing exercise. Patients doing exercise had a significantly lower risk of having ≥ 3 ultrasonographic enthesophytes and plantar aponeurosis enthesophytes. Nevertheless, those who engage in physical activity have a significantly higher risk of hypoechogenicity in the lateral epicondylar tendons.

Conclusions. Our study showed that exercise was associated with lower clinical disease activity. Physical activity can be responsible for ultrasonographic tendon insertion damage, but it doesn't accentuate the structural damage. The promotion of physical activity should be considered a healthcare priority.

KEY WORDS

Physical activity; exercise; entheses; ultrasonography; spondyloarthritis.

INTRODUCTION

Radiographic axial Spondyloarthritis (SpA), also called ankylosing spondylitis, is a chronic rheumatic disease affecting typically young men. Its prevalence ranges between 0.2% and 1.6% (1). Sacroiliac joints and spine involvement are the main characteristic features of SpA (2). It can be responsible for pain, stiffness, and disability.

The inflammation of entheses, also called enthesitis, is believed to be the central lesion in SpA (3). Entheses are skeletal anchorage points of the tendon, ligament, and joint capsule (4).

The pathophysiology of enthesis is not fully elucidated, pro-inflammatory cytokines (IL-17, IL-22, and IL-23) and metalloproteinases seem to be involved in this disease (5-8).

Enthesitis can be asymptomatic or responsible for inflammatory pain (9). Ultrasonography (US) can detect subclinical enthesitis (10-13) and reveal early entheseal abnormalities (14, 15).
The therapeutic management of axial and entheseal manifestations is based on non-steroidal anti-inflammatory drugs (NSAIDs) and biological Disease-Modifying Anti-Rheumatic drugs (bDMARDs). The treatment goal is to achieve remission or at least low disease activity (16).
Several scores are used to assess axial disease activity and clinical and US entheses involvement. Data regarding the relationship between physical activity and disease activity and entheses scores in SpA patients are scarce.
The effect of physical activity on SpA disease activity and enthesitis is unknown.
The aim of this study was to assess the association between physical activity, disease activity, and ultrasonographic entheseal abnormalities in SpA patients.

METHODS

Patients

We conducted a cross-sectional study including consecutive patients followed for SpA and recruited from the outpatient clinic of the rheumatology department.

Inclusion criteria

We included patients fulfilling the Assessment of SpondyloArthritis International Society (ASAS) 2009 criteria (17).

Non-inclusion criteria

Non-inclusion criteria were SAPHO (Synovitis-Acne-Pustulosis-Hyperostosis-Osteitis) syndrome and crystal-induced arthritis.

Clinical assessment

The following patients' and SpA characteristics were collected: age, gender, body mass index (BMI), age of SpA onset, disease duration, extra-articular manifestations (uveitis, psoriasis, inflammatory bowel disease (IBD), pulmonary involvement, cardiac involvement, renal involvement, and osteoporosis), comorbidities according to the European League Against Rheumatism (EULAR) (18), and therapeutic management (NSAIDs, conventional synthetic DMARDs (csDMARDs), and bDMARDs).
Disease activity was assessed using Bath Ankylosing Spondylitis Disease Activity Index (BASDAI) (19) and the Ankylosing Spondylitis Disease Activity Score ($ASDAS_{CRP}$) (20). Active disease corresponds to an $ASDAS_{CRP}$ higher than 2.1 or BASDAI higher than 4.
Clinical assessment of enthesitis was performed using the Maastricht Ankylosing Spondylitis Enthesitis Score (MASES), Spondyloarthritis Research Consortium of Canada Enthesitis Index (SPARCC), and Leeds Enthesitis Index (LEI).

Physical activity and exercise evaluation

Physical activity is any bodily movement that increases energy expenditure above resting levels. However, exercise, is a subset of physical activity that is planned, structured and repetitive: jogging, biking, playing football or tennis, weightlifting, *etc.* (21).
Physical activity was assessed using the University of California and Los Angeles (UCLA) and the Tegner activity scales. UCLA activity scale is a 10-item scale including 10 descriptive activity levels ranging from wholly inactive and dependent on others (level 1), to regular participation in impact sports such as jogging or tennis (level 10) (22, 23).
Tegner activity scale is an 11-item scale with activity levels ranging from 0 (sick leave or disability) to 10 (competitive sports (national elite)) (24).
The patients were also asked to estimate the weekly duration of exercise and of physical activity.

Biological assessment

Erythrocyte sedimentation rate (ESR) and C-reactive protein (CRP) levels were measured.

Ultrasonography assessment

A board-certified rheumatologist trained in ultrasonography performed the US examination. The rheumatologist was blinded for clinical data. The US evaluation was performed using a Mindray DC-70 device equipped with a 6-16 MHz linear transducer. The US was carried out after 15 minutes of rest at a room temperature maintained at 20 °C.
We explored the entheses of the quadricipital tendon (QT), proximal patellar tendon (PPT), distal patellar tendon (DPT), calcaneal tendon (CT), plantar aponeurosis (PA), lateral epicondyles (LET), and triceps tendon (TT).
For each patient, we calculated the following ultrasonographic enthesitis assessment scores: Spanish Enthesitis Index (SEI) (25), Glasgow Ultrasound Enthesitis Scoring System (GUESS) (12), and Madrid Sonographic Enthesitis Index (MASEI) (11).
The enthesis was assessed according to the Outcome Measures Rheumatoid Arthritis Clinical (OMERACT) recommendations (26), which means 2 mm of the insertion of the bony cortex on both longitudinal and transversal axes. For each enthesis, we specified the presence or not of enthesophyte, hypoechogenicity, calcification, or bony erosion.
Evaluated US abnormalities were:

- US tendon insertion damage: visualized as a thickened tendon or structural changes of the tendon insertion (hypoechoic or loss of its fibrillated appearance). The following cut-offs were used to define a thickened tendon: 5.29 mm for the CT, 4.4 mm for the PA, 6.1 mm for QT, 4 mm for both PPT and DPT (12), 4.3 for TT (11), and 3 mm for LET (27).
- Structural damage corresponds to enthesophytes, calcifications, or erosions.
- A power Doppler (PD) was evaluated at the bony insertion of the enthesis and was scored as a binary item (negative if absent and positive if any signal was present).

Statistical analyses

Statistical analyses were performed using Statistical Package for Social Sciences (SPSS) version 23. Quantitative variables were tested for normal distribution using the Shapiro-Wilk test.

We compared means of independent series using the independent samples Student T test for normally distributed variables. We performed the Mann-Whitney test to compare continuous variables with non-normal distribution. The Chi-square test was performed to assess the association between two categorical variables. As the number of patients was higher than 30, correlations between the tendon thickening and clinical or biological parameters were tested by Pearson's correlation coefficient. The prevalence ratio (PR) was used to quantify the link between independent variables and physical activity or high disease activity. We performed a stepwise backward binary logistic regression to identify risk factors independently associated with high disease activity (25) and US abnormalities associated with physical activity.

For this study, we included parameters that were significantly associated within the univariate analysis and those having a P-value < 0.20. All statistical tests were two-sided, and the level of statistical significance was set up at (P-value < 0.05).

Ethical consideration

This study was approved by the ethics committee of the Military Hospital of Tunis (Local Person Protection Committee, Military Hospital of Tunis. Number protocol: 81/2020/CLPP - date of approval: November 10, 2020). It was conducted according to the Declaration of Helsinki. Each participant signed consent after explaining the aims and methods of the study.

RESULTS

Patients' characteristics

A total number of 518 entheses was assessed. We included 37 patients (29 men (78%) and 8 women (22%)). The mean age was 44.6 ± 12.3 years. The mean BMI was 26.5 ± 4.1 kg/m². Using BASDAI, 23 patients had active disease.

Clinical and biological characteristics are summarized in **table I**.

Physical activity characteristics

Fifty-one percent of patients practiced exercises.

Aerobic exercise was performed by 49% of patients (n = 19) (walking: 27%, jogging: 8%, football: 5%, biking: 3%, handball: 3%, and fitness exercise: 3%). Anaerobic exercise (weightlifting) was performed by only one patient. Variations of UCLA physical activity scale and Tegner activity scale are represented in the **figure 1**.

Physical activity characteristics are summarized in **table I**.

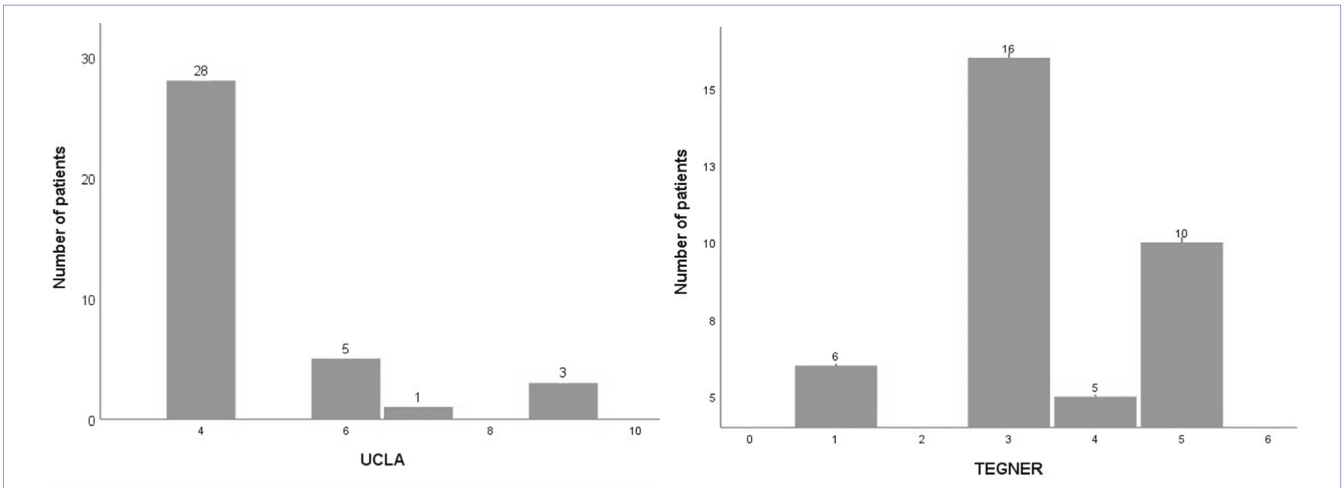

Figure 1. Variation of UCLA physical activity scale and Tegner activity scale.

Table I. SpA patients' characteristics.

Variables	
Clinical characteristics	
Age at onset, mean ± SD years	38.1 ± 11.3
Disease duration, median (IQR 25%-75%), years	5.3 (3 – 14)
BASDAI, mean ± SD	4.5 ±2.2
$ASDAS_{ESR}$, mean ± SD	3.2 ±1.3
$ASDAS_{CRP}$, mean ± SD	3 ± 1.2
Extra-articular manifestations, n (%)	15 (41)
Comorbidities, n (%)	19 (51)
Treatment	
NSAIDs n (%)	23 (92)
Continuous NSAIDs n (%)	12 (32)
bDMARDs n (%)	10 (27)
Biological characteristics	
CRP, median (IQR 25%-75%), mg/L	8 (4 -33.5)
ESR, median (IQR 25%-75%), mm	28 (11 - 66.5)
Clinical assessment of enthesitis	
Painful entheses, median (IQR 25%-75%)	5 (2-12)
MASES, median (IQR 25%-75%)	2 (0.5-5)
LEI, median (IQR 25%-75%)	1 (0-2)
SPARCC, median (IQR 25%-75%)	2 (0-4.5)
Ultrasound assessment of enthesitis	
SEI, mean ± SD	12.46±3.79
GUESS, mean ± SD	9.62±3.86
MASEI, mean ± SD	25.76±9.79
Physical activity characteristics	
Patients doing exercises, n (%)	19 (51)
Weekly duration of exercise, median (IQR 25%-75%), hours	0.75 (0-3.5)
Weekly duration of physical activity (IQR 25%-75%), hours	3 (1.9 - 7)
UCLA activity scale, median (IQR 25%-75%)	4 (4-5)
Tegner physical activity scale, median (IQR 25%-75%)	3 (3-5)

Values are expressed as mean ± SD (standard deviation); n: subjects number; BMI: Body mass index; BASDAI: Bath Ankylosing Spondylitis Disease Activity Index; ASDAS: Ankylosing Spondylitis Disease Activity Score; CRP: c-reactive protein; ESR: erythrocyte sedimentation rate; NSAIDs: Non-steroidal anti-inflammatory drugs; bDMARDs: biological disease-modifying anti-rheumatic drugs; MASES: Maastricht Ankylosing Spondylitis Enthesitis Score; SPARCC: Spondyloarthritis Research Consortium of Canada Enthesitis Index; LEI: Leeds Enthesitis Index; SEI: Spanish Enthesitis Index; GUESS: Glasgow Ultrasound Enthesitis Scoring System; MASEI: Madrid Sonographic Enthesitis Index UCLA: University of California and Los Angeles activity scale; IQR: interquartile range.

Clinical and US entheses characteristics

Fourteen patients had > 3 US enthesophytes.

As shown in **table II,** US entheses abnormalities were frequent. The CT enthesis was the most affected, followed by the PA in the lower limbs. Enthesophytes affecting LET and TT were found in 57% of patients.

Structural damages were found mainly in QT, CT, and PA.

The median number of painful entheses was 5 (IQR: 2-12) entheses.

The median (IQR 25%-75%) MASES, LEI, and SPARCC were 2 (0.5-5), 1 (0-2), and 2 (0-4.5), respectively.

The mean SEI, GUESS, and MASEI were 12.4 ± 3.7, 8.2 ± 3.8, and 25.7 ± 9.7, respectively.

Table II. US entheses abnormalities.

US abnormalities		Quadriceps tendon enthesis	Proximal insertion of the patellar tendon	Distal insertion of the patellar tendon	Calcaneal tendon	Plantar aponeurosis	Lateral epicondyle tendon	Triceps tendon
Tendon damage at its bone insertion	Tendon damage*, n (%)	34 (92)	19 (51)	30 (81)	36 (97)	36 (98)	26 (70)	30 (81)
	Thickening, (mm)	6.9 ± 0.8†	4 (3.7 - 4.5)	4.4 (4.1 -4.8)	4.9 ± 0.8†	5 (4.6-5.5)†	4.1 ± 0.6	5.1± 1.1†
	Thickened tendon, n (%)	27 (73)	17 (46)	29 (78)	15 (41)	35 (95)	11 (30)	30 (81)
	Hypo echogenecity, n (%)	25 (68)	5 (14)	20 (46)	32 (87)	17 (46)	21 (57)	13 (35)
	Loss of the fibrillated appearance	11 (30)	2 (5)	5 (14)	12 (32)	8 (22%)	7 (19)	1 (3)
Structural damage	Structural damage**, n (%)	26 (70)	8 (22)	11 (30)	34 (92)	29 (78)	29 (78)	27 (73)
	Enthesophytes, n (%)	25 (68)	6 (16)	6 (16)	30 (81)	21 (57)	21 (57)	12 (32)
	Calcifications, n (%)	12 (32)	3 (8)	13 (35)	13 (35)	13 (35)	14 (38)	18 (49)
	Erosions, n (%)	1 (3)	1 (3)	2 (5)	2 (5)	11 (30)	3 (8)	9 (24)
PD signal		2 (5)	1 (3)	1 (3)	3 (8)	11 (30)	7 (19)	1 (3)

US: ultrasonography; PD: power Doppler; p: significance value; *presence of a thickened tendon and/or hypoechoic appearance and/or loss of the fibrillated appearance of the tendon; **presence of calcifications; enthesophytes; or erosions; n: subjects' number; SD: standard deviation; values are expressed as mean ± standard deviation; †values are expressed as median (interquartile range).

Relationship between physical activity and clinical characteristics of the disease

As shown in **table III**, patients who performed exercise had a significantly lower disease activity, mean number of painful entheses, and lower clinical enthesis scores.

We found that exercise was associated with a lower risk of disease activity (PR: 0.288, p = 0.01, 95%CI 0.096-0.866).

As shown in **table IV**, negative correlations were found between the weekly duration of exercise and the following parameters: BASDAI, number of painful entheses,

Table III. Association between disease activity, entheses scores, and exercise.

	Exercise		P-value
	No (n = 18)	Yes (n = 19)	
BASDAI	5.4 ± 1.9	3.5 ± 2	**0.004**
$ASDAS_{CRP}$	3.4 ± 1.1	2.6 ± 1.1	**0.05**
$ASDAS_{ESR}$	3.7 ± 1.1	2.8 ± 1.3	**0.04**
CRP	39.6 ± 58.5	16.1 ± 20.1	0.107
ESR	48.7 ± 37.4	34.7 ± 30	0.217
Painful entheses	9.1 ± 6.4	3.9 ± 4.5	**0.008**
MASES	4.2 ± 3.2	1.7 ± 1.8	**0.016**
LEI	2.1 ± 1.9	0.9 ± 1.2	**0.04**
SPARCC	4.2 ± 3.5	1.7 ± 2.9	**0.011**
SEI	12.3 ± 4	12.6 ± 3.6	0.781
GUESS	10.1 ± 4	9.2 ± 3.8	0.513
MASEI	26.7 ± 10.8	24.9 ± 8.9	0.590

Values are expressed as mean ± SD (standard deviation); n: subjects' number; p: significance value; BASDAI: Bath Ankylosing Spondylitis Disease Activity Index; ASDAS: Ankylosing Spondylitis Disease Activity Score; CRP: C-reactive protein; ESR: Erythrocyte Sedimentation Rate; MASES: Maastricht Ankylosing Spondylitis Enthesitis Score; SPARCC: Spondyloarthritis Research Consortium of Canada Enthesitis Index; LEI: Leeds Enthesitis Index; SEI: Spanish Enthesitis Index; GUESS: Glasgow Ultrasound Enthesitis Scoring System; MASEI: Madrid Sonographic Enthesitis Index; NS: not significant.

SPARCC, and MASES. A negative correlation was also found between the weekly duration of physical activity and MASES. No correlations were found between these parameters and UCLA or Tegner activity scales.
In the multivariate study, we found that high disease activity was associated with increased inflammatory biomarkers (OR 6.565, p = 0.04, 95%CI 1.092-39.459). Nevertheless, exercise was associated with a lower risk of disease activity (OR 0.123, p = 0.022, 95%CI 0.020 -0.742).

Relationship between physical activity and ultrasonographic characteristics

Triceps tendon thickening, the SEI, and thickening of the distal insertion of the patellar tendon were significantly higher in patients performing physical activity (triceps tendon's thickening: 4.20 ± 0.62 *vs* 3.7 ± 0.3 mm, p = 0.044; SEI of the distal insertion of the patellar tendon: 2.5 ± 1.4 *vs* 1.1 ± 1.1, p = 0.03, and thickening of the distal insertion of the patellar tendon: 4.6 ± 0.7 *vs* 3.9 ± 0.3, p = 0.02). The thickness of the lateral epicondyle enthesis was also positively correlated with weekly duration of physical activity as shown in **table IV**.
Patients doing exercise had a significantly lower risk of having ≥ 3 US enthesophytes (PR: 0.22; 95%CI 0.3-0.9, p = 0.031) and PA enthesophyte (PR: 0.188; 95%CI 0.04-0.87, p = 0.026).
Patients doing physical activity had a higher risk of hypoechogenicity in the distal insertion of the patellar tendon (PR: 2.88; 95%CI 1.75-4.5, p = 0.004). A higher UCLA activity scale was found in patients with loss of the fibrillar aspect of the DPT (6 ± 2.73 *vs* 4.56 ± 1.18, p = 0.047).
Lower UCLA was found in patients with structural damage lesions of the QT (4.42 ± 1.13 *vs* 5.54 ± 2.01, p = 0.038) and TT enthesitis (4.34 ± 1.09 *vs* 5.72 ± 1.95, p = 0.09).
Lower Tegner activity scale was found in patients with the following US abnormalities: loss of the fibrillar aspect of EPL (2.5 ± 1.3 *vs* 3.58 ± 1.26, p = 0.04) and with TT calcification (2.71 ± 1.48 *vs* 3.73 ± 1.09, p = 0.022).
Besides, a negative correlation was found between MASEI and UCLA activity index (r = -0.326, p = 0.049). However, Tegner activity scale was positively correlated with the thickness of the PPT (r = 0.349, p = 0.034).

Table IV. Correlations between clinical and ultrasonographic characteristics and physical activity characteristics.

	Age	Weekly duration of exercise	Weekly duration of physical activity	UCLA activity scale	Tegner Physical Activity scale
BASDAI	0.313	**-0.363***	-0.121	-0.199	-0.107
ASDAS ESR	0.247	-0.196	-0.009	-0.167	-0.105
ASDAS CRP	0.267	-0.155	0.140	-0.084	0.032
number of painful entheses	0.284	**-0.425****	-0.321	-0.281	-0.274
SPARCC	**0.373***	**-0.414***	-0.292	-0.242	-0.270
MASES	0.121	**-0.401***	**-0.326***	-0.291	-0.183
LEI	**0.329***	-0.323	-0.189	-0.206	-0.128
SEI	0.247	0.295	0.286	-0.183	0.126
GUESS	**0.379***	-0.097	0.058	-0.196	0.080
MASEI	**0.450****	0.032	0.159	**-0.326***	-0.010
Tendon thickness					
QT	**0.332***	0.258	0.045	0.169	0.086
PPT	0	0.147	-0.093	0.019	**0.349***
DPT	-0.015	0.039	0.061	-0.048	0.108
CT	**0.343***	-0.029	0.131	-0.158	0.200
PA	0.209	0.006	0.246	0.050	-0.016
LET	0.124	**0.378***	0.306	0.119	-0.138
TT	0.213	0.114	0.172	-0.146	-0.018

Data are presented as r of Pearson correlations; *p < 0.05; **p < 0.01; ***p < 0.001; BASDAI: Bath Ankylosing Spondylitis Disease Activity Index; ASDAS: Ankylosing Spondylitis Disease Activity Score; ESR: Erythrocyte Sedimentation Rate; CRP: C-reactive protein; MASES: Maastricht Ankylosing Spondylitis Enthesitis Score; SPARCC: Spondyloarthritis Research Consortium of Canada Enthesitis Index; LEI: Leeds Enthesitis Index; SEI: Spanish Enthesitis Index; GUESS: Glasgow Ultrasound Enthesitis Scoring System; MASEI: Madrid Sonographic Enthesitis Index; QT: Quadriceps tendon enthesis; PPT: Proximal insertion of the patellar tendon; DPT: Distal insertion of the patellar tendon; CT: Calcaneal tendon; PA: Plantar aponeurosis; LET: Lateral epicondyle tendon; TT: triceps tendon; UCLA: University of California and Los Angeles activity scale.

In the multivariate study, we found that exercise was associated with a lower risk of having ≥ 3 enthesophytes (OR 0.213, p = 0.036, 95%CI 0.05-0.90).

DISCUSSION

We attempted to assess the association between physical activity, disease activity, and ultrasonographic entheseal abnormalities in SpA patients.

Our study showed that patients who performed regular exercise had significantly lower disease activity. However, UCLA and Tegner activity scales were not correlated with disease activity.

There are controversial results regarding the effect of physical activity on disease activity and entheses. Two clinical trials assessed the effect of physical activity on psoriatic arthritis patients. No adverse events related to exercise or inflammatory flares of disease had been reported (28, 29). However, in Häkkinen's study, inflammatory flare occurred in six psoriatic arthritis patients in the exercise group and five patients in the control group leading to a temporary stoppage of the protocol (30). In their systematic review, Kessler *et al.* emphasize the widespread benefits of physical activity on psoriatic arthritis patients regarding functional capacity, general well-being, fatigue, and quality of life (31).

In a study including SpA patients, the authors demonstrated that a 3-month combined home exercise associating range-of-motion, strengthening, and aerobic exercise was more effective than range-of-motion home exercise alone in terms of aerobic capacity and functional ability assessed using Bath Ankylosing Spondylitis Functional Index (BASFI) (32).

Jennings *et al.* found that aerobic exercise associated with stretching or stretching alone could improve the functional capacity of SpA patients (33).

In a metanalysis including twenty-six trials with a total of 1,286 patients followed for inflammatory rheumatic diseases, the authors demonstrated a beneficial effect of physical activity on disease activity scores (Standardized Mean Difference (SMD): 0.19, 95%CI 0.05-0.33, p < 0.01), joint damage (SMD: 0.27, 95%CI 0.07-0.46, p < 0.01), and ESR (SMD: 0.20, 95%CI 0.0-0.39, p = 0.04) (34).

We did not find a significant difference in ESR and CRP between patients with or without physical activity. Nevertheless, patients doing exercise had a significantly lower disease activity.

This finding highlights that physical activity can be considered a non-pharmacological treatment for the management of spondyloarthritis. Therefore, regular physical activity, including cardiorespiratory fitness, muscle strength, flexibility, and neuromotor performance, is highly recommended for patients with inflammatory diseases (35).

Data regarding the effects of physical activity on entheses involvement in patients with SpA are scarce. Our study showed that physical activity was associated with a lower clinical enthesitis score. Besides, negative correlations were found between the weekly duration of exercise and the following parameters: number of painful entheses, SPARCC, and MASES. These correlations were not found with UCLA and Tegner activity scales.

A negative correlation was also found between the weekly duration of physical activity and MASES. These results highlight the beneficial effect of physical activity on clinical entheses scores.

To our knowledge, the link between physical activity and US enthesis score has not been studied in axial spondyloarthritis patients. We did not find a significant difference in US scores between patients doing or not doing exercise.

In a study including 84 patients followed for psoriatic arthritis, patients reporting avoidance of activity had lower MASEI (β: -1.71, 95%CI -3.1 to -0.32) than those who did not (36).

Triceps tendon thickening, SEI, and thickening of the distal insertion of the patellar tendon were higher in patients performing physical activity. Patients doing physical activity had also a higher risk of hypoechogenicity in the lateral epicondyle tendons.

Bakirci *et al.* showed that US changes within the enthesis of healthy subjects were associated with physical activity (β: 4.41, 95%CI 1.25-7.58, p = 0.007). Thickening was the common lesion, affecting mostly the patellar tendon insertions (37).

This result suggests that biomechanical forces on the enthesis can be responsible for US entheses abnormalities without any signs and symptoms.

The effect of physical activity on entheses depends on the type and amount of exercise.

The onset of sports-related enthesopathy seemed to be due to muscle contraction rather than the amount of exercise (38). Ozone *et al.* showed that, unlike concentric contraction-dominant exercises, eccentric contraction-dominant exercise can be responsible for sports-related enthesopathy-like morphological changes via the activation of transforming growth factor-β superfamily pathway in enthesis (39).

In our study, patients with loss of the fibrillar aspect of the DPT had significantly higher UCLA activity scale. This score was, however, negatively correlated with MASEI. A lower Tegner activity scale was found in patients with loss of the fibrillar aspect of EPL and with TT calcification.

Interestingly, we found that patients doing exercise had a lower risk of having ≥ 3 US enthesophytes and plantar aponeurosis enthesophyte.

These results suggest that physical activity can be responsible for US tendon insertion damage due to biomechanical forces on the enthesis. However, physical activity did not accentuate the structural damage. It could even prevent structural damage.

This study highlights an association between physical activity, disease activity, and clinical and ultrasonographic entheseal abnormalities. However, a cause-effect relationship between exercise and disease activity cannot be readily established. Indeed, it is unclear whether patients with low disease activity practice exercise because their state of health allows it or whether those who practice exercise have lower disease activity because of the beneficial effect of physical activity on disease. In fact, our study had some limitations that included the small sample size and the consequently low statistical power (the statistical power of our study was 9.086% based on normal approximation and 4.278% based on normal approximation with continuity correction).

CONCLUSIONS

Our study showed that patients who exercise had significantly lower disease activity. These findings suggest that physical activity could be considered a non-pharmacological treatment for the management of spondyloarthritis and can be recommended for these patients. We also found that physical activity was associated with a lower clinical enthesitis scores. It can be responsible for ultrasonographic tendon insertion damage, but it doesn't accentuate the structural damage. The promotion of physical activity could be considered a healthcare priority.

FUNDINGS

None.

CONTRIBUTIONS

MS: ultrasonography performance, writing – original draft. SBD, LK: writing – original draft, data collection. HB, CB: data analysis. IG: conceptualization.

DATA AVAILABILITY

Data are available under reasonable request to the corresponding author.

CONFLICT OF INTERESTS

The authors declare that they have no conflict of interests.

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