


SHORT REPORT

Tolerability of low to moderate biomechanical stress during leisure sport activity in patients with psoriasis and psoriatic arthritis

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ABSTRACT

Objectives To assess the impact of low to moderate biomechanical stress on entheses in patients with psoriasis and psoriatic arthritis (PsA).

Methods We conducted a prospective interventional study on a cohort of psoriasis and PsA patients who underwent a 60 min badminton training session. Pain assessment by Visual Analogue Scale (VAS), physical examination of 29 entheses (SPARCC, LEI, MASES) and bilateral ultrasound at the lateral humeral epicondyle, inferior patellar pole and Achilles tendon were performed before and after training. Ultrasound changes were assessed using the OMERACT scoring system. A follow-up assessment of pain and adverse events was performed at 1 week.

Results Sixteen patients were included (n=7 PsA; n=9 psoriasis) and 196 enthesal ultrasound scans were acquired. At baseline, median VAS pain (IQR) was 0.5 cm (0–2.3) and the total number of tender entheses was 12/464. Mean (min; max) Disease Activity Index for Psoriatic Arthritis was 6.1 (0.8; 19) and 5/7 PsA patients had an Minimal Disease Activity status. After training, no significant change in VAS pain (0.0 cm (0.0–2.0)) nor in tender entheses (13/464) emerged. Four patients (n=2 PsA, n=2 psoriasis) developed a grade-1 power Doppler-signal at six entheses, which, however, remained non-tender. At 1 week, median VAS pain remained stable (0.0 cm (0.0–3.0); p>0.05) and only one participant with active PsA at baseline reported increased arthralgias in three joints.

Conclusions Low to moderate physical strain, as in the context of leisure sport activity, seems well tolerated in psoriatic patients without increases in tenderness, pain and ultrasound-proven inflammation. Evidence-based recommendations for physical activity in PsA are direly needed and larger controlled studies should be conducted to define safe exercise thresholds.

INTRODUCTION

In psoriatic arthritis (PsA), biomechanical loading is thought to be implicated in triggering the development of enthesitis. This model of mechanoinflammation or ‘Deep Koebner phenomenon’ is a translation to the musculoskeletal system of the Koebner

WHAT IS ALREADY KNOWN ON THIS TOPIC

- ⇒ Pre-clinical studies suggest that mechanical strain is a key driver of enthesitis and that psoriatic patients may have a reduced tolerance to biomechanical stressors.
- ⇒ Safe thresholds for physical activity for psoriatic patients have not been determined yet, hindering the development of effective physical therapy programmes.

WHAT THIS STUDY ADDS

- ⇒ Our interventional study provided real-life data on the impact of biomechanical stress on the entheses of psoriatic patients at varying degrees of disease activity.
- ⇒ Moderate physical strain did not lead to relevant changes in enthesal tenderness, ultrasound-proven inflammation, and pain at 1 week and was well tolerated in this enthesitis-prone patient group.

HOW THIS STUDY MIGHT AFFECT RESEARCH, PRACTICE OR POLICY

- ⇒ Our results suggest that exercise programmes with low to moderate workload on the entheses can be safely implemented for patients with psoriasis and psoriatic arthritis with good disease control.

phenomenon of mechanically induced skin inflammation known in cutaneous psoriasis and provides an appealing explanation for the pathologically exaggerated inflammatory reactions observed in PsA.^{1,2} In line with this phenomenon, translational mice models of spondyloarthritis could demonstrate that biomechanical stress functions as an on/off switch for enthesitis.³ However, two recent randomised controlled trials on spondyloarthritis, including PsA, showed that high-intensity training did not result in increased disease activity.^{4,5} European League against Rheumatism (EULAR) and American College of Rheumatology guidelines advise physical

Table 1 Baseline characteristics of PsA and psoriasis patients

	PsA	Psoriasis
N	7	9
Female sex, n (%)	1 (14)	3 (33)
Age, years, mean (SD)	39.3 (10.3)	44.1 (10.9)
Disease duration, years, mean (SD)	16.9 (14.2)	24.3 (14.8)
Current smokers, n (%)	1/7 (14)	3/9 (33)
Body mass index, mean (SD)	30.0 (8.6)	23.7 (1.7)
Involvement pattern of PsA, n (%)		
Peripheral involvement	7 (100)	–
Axial involvement	3 (43)	–
Presence of synovitis	7 (100)	–
Presence of enthesitis	7 (100)	–
Comorbidities, n (%)		
Comorbidity n=1	1(14)	2 (22)
Comorbidities n>1	2 (29)	1(11)
Inflammatory bowel disease, n	2 (29)	1(11)
Uveitis,	0 (0)	1(11)
Frequency of sport activity, n (%)		
Less than once monthly	2 (29)	2 (22)
Once monthly	1(14)	0 (0)
Once to twice weekly	0 (0)	4 (44)
More than three times weekly	3 (43)	4 (44)
Systemic therapy, n (%)		
No systemic therapy	1(14)	6 (67)
csDMARD	1(14)	0 (0)
tsDMARD	2 (29)	1(11)
TNF inhibitors	1(14)	1(11)
IL-17 inhibitors	1(14)	1(11)
IL-23 inhibitors	1(14)	0 (0)
Disease activity		
TJC, mean (min; max)	2.0 (0.0; 6.0)	–
SJC, mean (min; max)	0.3 (0.0; 2.0)	–
PASI, mean (min; max)	2.5 (0.0; 7.5)	3.2 (0.0; 7.2)
DAPSA, mean (min; max)	6.1 (0.8; 19.0)	–
MDA, n (%)	5 (71)	–
cs/ts/DMARDs, conventional synthetic/targeted synthetic disease-modifying antirheumatic drugs; DAPSA, Disease Activity Index for Psoriatic Arthritis; IL, interleukin; MDA, Minimal Disease Activity score; PASI, Psoriasis Area and Severity Index; PsA, psoriatic arthritis; SJC, swollen joint count; TJC, tender joint count; TNF, tumour necrosis factor .		

activity as a complementary measure to drug treatment for patients with rheumatoid arthritis,^{6 7} but this can hardly be extrapolated for PsA. The absence of specific guidelines has detrimental effects on the standard of care offered to PsA patients and ultimately on patient's quality of life. Epidemiological studies have found that the majority of PsA patients, especially young women, have a sedentary lifestyle, and a significant proportion avoids

exercise voluntarily.^{8 9} Hence, determining safe thresholds for physical training is necessary for defining effective preventive and interventional measures. In this context, we aimed to assess the effects of mechanical strain on the entheses of psoriasis and PsA patients exposed to low to moderate whole-body physical activity via a badminton training session, which exerts considerable mechanical stress on both upper and lower extremities.

METHODS

Participants

We conducted a prospective interventional study on a cohort of dermatologist-diagnosed psoriasis patients and PsA patients fulfilling the CASPAR (CLASSification criteria for Psoriatic ARthritis) criteria who underwent no changes in immune-suppressive medications in the 3 months prior to the intervention.¹⁰ Participants underwent a single 60 min session of active badminton training. Patients were evaluated before and immediately after exercise, without prior care such as stretching, shower or cryotherapy. A physical examination of 29 entheses (AJH) and bilateral ultrasound of the entheses at the lateral humeral epicondyle, inferior patellar pole and Achilles tendon (AK) was performed. Data on clinical history, disease activity, treatment and patient-reported frequency of sport activity were collected. The presence of comorbidities (osteoporosis, gout, osteoarthritis, asthma, hypertension, diabetes, chronic kidney disease) was assessed. Disease activity was measured by Disease Activity Index for Psoriatic Arthritis (DAPSA)¹¹ and Minimal Disease Activity (MDA)¹² scores. Patient pain was assessed using the Visual Analogue Scale (VAS) before and after physical activity. A follow-up assessment of pain and adverse events was performed 1 week afterward by telephone interview.

Ultrasound assessment

Power Doppler (PD) signal and Grayscale changes were assessed by two blinded expert readers (MYM and FF) according to the OMERACT (Outcome Measures in Rheumatology) scoring system.¹³ In case of discordance, consensus was reached by discussion (n=2). Data on clinical history, disease activity measures and physical activity were collected. Patient pain was assessed by VAS before and after training. A follow-up assessment of pain and adverse events was performed 1 week after training.

Statistical methods

Participant characteristics were described using means with SD and median with IQRs for continuous variables, or counts and percentages for categorical variables. A paired t-test was conducted to evaluate the statistical significance of the observed differences pretraining and post-training. This test allows a direct comparison of the mean observed differences within the individual participant, thereby minimising the effect of interindividual variability. In addition, a one-sample exact binomial test was used to determine whether the results of the previous

tests could be considered random effects due to the small sample size and data sparsity. All p values were two sided and considered significant if ≤ 0.05 without multiplicity adjustment. Statistical analyses were conducted using R V.4.2.1 (R Foundation, 2022) in RStudio V.2023.03.0+386 (PBC).

RESULTS

Study population

Seven patients with PsA and nine patients with psoriasis were included. The majority of participants were male (75%) and the mean age (SD) was 42 (± 10.6), mean body mass index (BMI) was 26.4 (± 6.4). One or more comorbidities were present in 37.5% of patients. All but one PsA patient and 3/9 psoriasis patients were receiving immunomodulatory therapy with disease-modifying antirheumatic drugs. 43.8% of patients reported engaging in sport activity more than three times weekly, while 25.0% had a predominantly sedentary lifestyle and exercised less than once a month. Only three patients had previous experience playing badminton at amateur level. Baseline clinical characteristics by diagnosis are reported in [table 1](#). At baseline, the median VAS pain (IQR) was 0.5 cm (0–2.3) and the total number of tender entheses was 12/464 (a total of 16 patients, each was clinically examined at 29 enthesal sites). PsA disease activity ranged from low to moderate with a mean (min; max) DAPSA of 6.1 (0.8; 19) and 5/7 patients with MDA⁹ achieved. After training, no significant change neither in median VAS pain (0.0 cm (0.0–2.0)) nor tender entheses (13/464) emerged. Baseline characteristics can be found in [table 1](#).

Ultrasound assessment of entheses

A total of 196 Grayscale and PD ultrasound scans were acquired. Baseline ultrasound showed structural changes in 15/96 entheses and inflammatory changes in 17/96 entheses (all 16 patients with each 6 ultrasound-assessed

entheses). Structural changes were exclusively represented by calcifications and enthesophytes. No patient showed evidence of erosions. Hypoechoogenicity of the entheses was the most frequent inflammatory finding (n=14), followed by thickening (n=2) and grade-1 PD signal (n=1). After training, four patients (n=2 PsA, n=2 Psoriasis) developed grade-1 PD signal at a total of six entheses ([figure 1](#)), which, however, remained clinically silent. Detailed clinical and ultrasound findings are reported in [table 2](#). The involved sites were the common extensor tendon entheses at the lateral humeral epicondyle (n=2) and the patellar tendon entheses at the tibial tuberosity (n=4). In all cases, no accompanying structural changes were present and the remaining ultrasound parameters remained unchanged. A paired t-test revealed that the difference in the observed inflammatory changes and PD signal was not significant (both $p=0.08$). To verify whether these observations could be considered random effects due to the low sample size a one-sample exact binomial test was performed, which confirmed the absence of significant differences.

Effect of physical activity after 1 week of follow-up

At the 1-week follow-up, median VAS pain remained stable (0.5 cm (0.0–3.0)). Only one PsA participant with active disease at baseline (DAPSA: 19) experienced an increase in disease activity with the onset of swelling and pain in the right ankle, wrist and knee joints, which was diagnosed as arthritis in a follow-up clinical assessment the same week. The patient was a 58-year-old male with a BMI of 39.4 kg/m² and was receiving only NSAIDs (nonsteroidal antiinflammatory drugs) without immune suppression at the time of study participation. In another psoriasis patient, mild lumbar pain was reported.

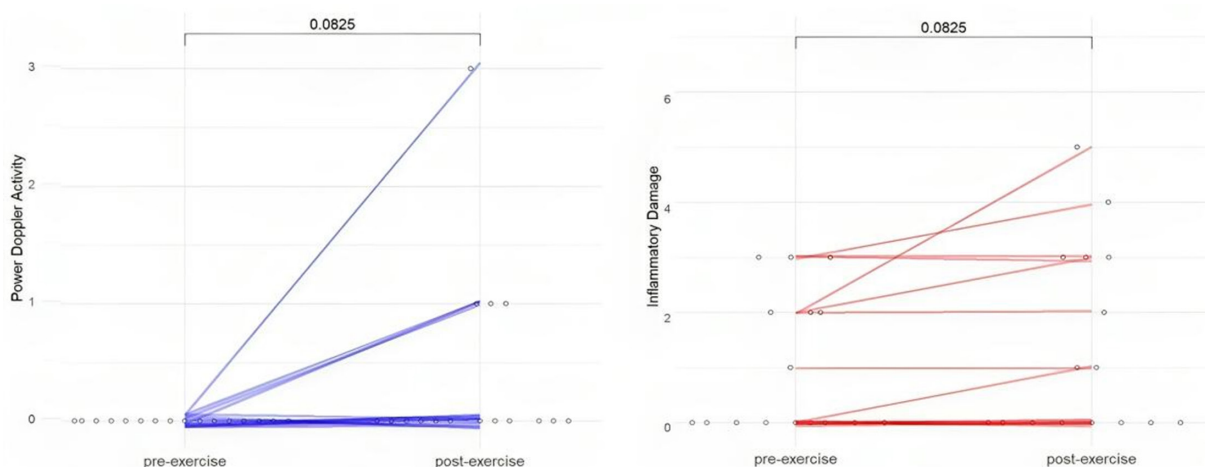


Figure 1 Spaghetti plots depicting the frequency of individual power Doppler ultrasound signals (left panel) and inflammatory ultrasound changes (ie, either hypoechoogenicity or thickening) (right panel) before and after training. A paired t-test revealed no significant difference in the frequency of power Doppler activity ($p=0.08$) and inflammatory changes ($p=0.08$) in the preexercise and postexercise measurements.

Table 2 Clinical and ultrasound findings before and after training

	Before training	After training
Clinical evaluation (N=464 entheses)		
Effected entheses, n (%)	12 (2.6)	13 (2.8)
LEI, median (min; max)	0 (0;3)	0 (0;3)
MASES, median (min; max)	0 (0;4)	0 (0;5)
SPARCC, median (min; max)	1 (0;9)	1 (0;10)
Sonographic evaluation (N=96 entheses)		
Inflammatory changes, n (%)	17 (17.7)	22 (22.9)
Hypoechogenicity	14 (14.5)	14 (14.5)
Thickening	2 (2.0)	2 (2.0)
Power Doppler signal	1 (1.0)	7 (7.2)
Structural changes, n (%)	15 (15.6)	15 (15.6)
Calcifications/enthesophytes	15 (15.6)	15 (15.6)
Erosions	0 (0)	0 (0)
LEI, Leeds Enthesitis Index; MASES, Maastricht Ankylosing Spondylitis Enthesitis Score; SPARCC, Spondyloarthritis Research Consortium of Canada enthesitis score.		

DISCUSSION

Our findings suggest that low-intensity training, as in the context of leisure physical activity, is likely safe for patients with psoriatic disease experiencing good disease control. While a few patients experienced a minor increase in PD signal, this remained clinically silent and did not lead to a later increase in disease activity. As the only flare in our cohort was observed in an untreated PsA patient, immunomodulatory therapy could possibly offer some protection against mechanically induced inflammation. The effects of biomechanical stress on the entheses in PsA are still not entirely understood. A recent cross-sectional study on a cohort of 84 PsA patients found that patients who declared avoiding physical activity had significantly lower rates of US-confirmed enthesitis compared with those who exercised regularly. Interestingly, however, in the same study, regular exercise was not associated with negative effects on enthesial inflammation,¹⁴ which is in line with our findings. Furthermore, both leisure and intense physical exercise were found associated with a lower risk of incident psoriasis in two large controlled studies, presumably due to positive effects on cardiometabolic comorbidities, and possibly to exercise-induced modulation of inflammatory responses.^{15 16} Nonetheless, since the role of biomechanical stress in inducing enthesitis holds solid pathophysiological bases, high-intensity sport should be practised carefully and adapted to individual physical skills.

Our results should be interpreted in the context of some limitations. First, the small sample size and absence of a control group do not allow us to draw definite conclusions. Second, patients with psoriasis did not have arthralgia and were not selected based on a higher risk of developing PsA (eg, scalp involvement, nail disease, family history). Third, only training time but not intensity

of exercise could be standardised, as some patients were more physically capable than others due to age-related and disease-related factors. Lastly, the effects of chronic exposure to physical strain were not investigated.

In general, regular exercise is known to be beneficial for pain, general health status and cardiometabolic comorbidities, which also significantly contribute to disease activity in PsA. However, the current scarcity of evidence does not allow us to make any more precise recommendations, and further, larger studies are needed to define which physical activity thresholds are safe in PsA. Generating this data is crucial for management decisions and ultimately developing evidence-based guidelines for physical activity in PsA.

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Contributors Study design: FF, GS, AK, DS and AJH. Data collection: FF, MYM, IM, MK, AK, DS and AJH. Ultrasound examinations and scoring: FF, MYM and AK. Tables: FF, MYM, SAT and AJH. Statistical analysis: FF and SAT. Conceptualising and writing of the manuscript: FF and MYM, SAT, GS, AK, DS and AJH.

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Competing interests None declared.

Patient consent for publication Consent obtained directly from patient(s)

Ethics approval This study involves human participants and the conduction of this study was approved by the ethics committee (#226_18B) of the university clinic of Erlangen. All patients signed written informed consent before study participation. Participants gave informed consent to participate in the study before taking part.

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