Do patients with skin psoriasis show subclinical axial inflammation on Magnetic Resonance Imaging of the sacroiliac joints and entire spine?

Bratu, Vlad A; Häusermann, Peter; Walker, Ulrich A; Daikeler, Thomas; Zubler, Veronika; Jaeger, Veronika K; Weber, Ulrich; Studler, Ueli

Published in: Arthritis Care & Research

DOI: 10.1002/acr.23767

Publication date: 2019

Document version Accepted manuscript


Terms of use
This work is brought to you by the University of Southern Denmark through the SDU Research Portal. Unless otherwise specified it has been shared according to the terms for self-archiving. If no other license is stated, these terms apply:

- You may download this work for personal use only.
- You may not further distribute the material or use it for any profit-making activity or commercial gain
- You may freely distribute the URL identifying this open access version

If you believe that this document breaches copyright please contact us providing details and we will investigate your claim. Please direct all enquiries to puresupport@bib.sdu.dk
Do patients with skin psoriasis show subclinical axial inflammation on MRI of the sacroiliac joints and entire spine?

Vlad A. Bratu¹,² MD, Peter Häusermann³ MD, Ulrich A. Walker⁴ MD, Thomas Daikeler⁴ MD, Veronika Zubler⁵ MD, Veronika K. Jaeger⁴ MSc MRes, Ulrich Weber⁶,⁷ MD, Ueli Studler¹,⁸ MD

¹UW and US share senior authorship

¹ Department of Radiology, University Hospital Basel, Basel, Switzerland

² Present Address: Department of Diagnostic and Interventional Neuroradiology, University Hospital Berne, Berne, Switzerland; vlad.bratu@insel.ch

³ Department of Dermatology, University Hospital Basel, Basel, Switzerland; peter.haeusermann@usb.ch

This article has been accepted for publication and undergone full peer review but has not been through the copyediting, typesetting, pagination and proofreading process, which may lead to differences between this version and the Version of Record. Please cite this article as doi: 10.1002/acr.23767

This article is protected by copyright. All rights reserved.
4 Department of Rheumatology, University Hospital Basel, Switzerland;
ulrich.walker@usb.ch

thomas.daikeler@usb.ch

veronika.jaeger@usb.ch

5 Department of Radiology, Orthopedic University Hospital Balgrist, Zurich, Switzerland; veronika.zubler@balgrist.ch

6 King Christian 10th Hospital for Rheumatic Diseases, Gråsten, Denmark;
ulrich.weber02@bluewin.ch

7 Institute of Regional Health Research, University of Southern Denmark, Odense, Denmark
ulrich.weber02@bluewin.ch

8 Present Address: Imamed, Radiologie Nordwest, Basel, Switzerland;
studleru@gmail.com

Correspondence

Ueli Studler, MD
Imamed Radiologie
Sternengasse 18
4051 Basel
Switzerland

This article is protected by copyright. All rights reserved.
Manuscript type
Original Article

Funding sources
Research and Travel Grant of Gottfried and Julia Bangerter-Rhyner Foundation
Lange Gasse 15
4002 Basel
Switzerland
http://www.bangerter-stiftung.ch/

Ethical committee approval
Ethikkommission Nordwest- und Zentralschweiz (EKNZ)
Hebelstrasse 53
4056 Basel
Switzerland
Approval number 341/09

Phone +41 61 686 42 42
Fax +41 61 686 42 43
studleru@gmail.com

This article is protected by copyright. All rights reserved.
Running head

Subclinical axial inflammation in skin psoriasis

Key words

Skin psoriasis; axial spondyloarthritis; magnetic resonance imaging; sacroiliac joints; spine

Competing interests

The authors declare that they have no competing interests in relation to this article. There was no financial support or other benefits from commercial sources for the work reported in the manuscript.

ABSTRACT

Objective: To explore potential subclinical involvement of the axial skeleton by MRI of the sacroiliac joints (SIJ) and entire spine in patients with skin psoriasis without clinical evidence of peripheral or axial inflammation.

Methods: Twenty patients with skin psoriasis but no clinical evidence of peripheral or axial inflammation and 22 healthy controls underwent standardized dermatologic and rheumatologic clinical examination and unenhanced 1.5T MRI of the SIJ and the entire spine. Two blinded readers globally assessed the presence or absence of SIJ inflammation simultaneously on T1-weighted and STIR MRI sequences with a confidence estimate. Bone marrow edema, fat metaplasia, erosion and ankylosis of the SIJ, and vertebral...
corner inflammatory and fat lesions were recorded using standardized modules. The prevalence of each lesion type was calculated in both groups averaged across 2 readers. The number of subjects with ≥1/2/3/4/5 lesions in the SIJ and spine as concordantly assessed by both readers was recorded.

**Results**: Median duration of skin psoriasis was 23.0 years, median age of patients 48.5 years. 25.0% of patients and 9.1% of healthy controls were concordantly classified by both readers as having SIJ inflammation (p=0.23). Prevalence of bone marrow edema and structural lesions was comparable across patients and controls both on SIJ and spine MRI.

**Conclusion**: In this controlled study, patients with skin psoriasis, but no clinical arthritis or spondylitis showed limited evidence of concomitant subclinical axial involvement by SIJ and spine MRI. These findings do not support routine screening for subclinical axial inflammation in patients with longstanding skin psoriasis.

**SIGNIFICANCE AND INNOVATIONS**

- In this controlled study, MRI of the axial skeleton showed only limited evidence of subclinical axial inflammation in patients with skin psoriasis but without clinical signs of peripheral or axial inflammation.

- 25% of patients with longstanding skin psoriasis and 9% of healthy controls were concordantly classified by 2 readers as having sacroiliitis. At least 3 spinal corner inflammatory lesions were concordantly reported in 25% of patients and 18% of controls. However, frequencies of inflammatory changes
on axial MRI showed no statistically significant differences between psoriasis patients and healthy controls (p>0.2).

- Our data do not support routine screening for potential subclinical axial inflammation in patients with longstanding skin psoriasis.

INTRODUCTION

Psoriasis vulgaris affects 2-3% of the population as a chronic, immune-mediated skin disease (1). According to a systematic review, a range of 7-26% of patients with skin psoriasis may develop psoriatic arthritis (PsA), a musculoskeletal disorder characterized by peripheral arthritis, enthesitis or spondylitis (2). Musculoskeletal symptoms compatible with PsA are usually diagnosed after onset of skin disease. However, it is increasingly recognized that inflammatory joint lesions may be present even in psoriatic patients without clinical evidence of arthritis - a condition termed occult or subclinical PsA (3, 4). A recent study found in almost half of patients with skin psoriasis subclinical inflammatory changes on magnetic resonance imaging (MRI) scans of the hand (5). Other studies showed a substantial prevalence of subclinical signs of enthesitis and peripheral joint synovitis by ultrasound when psoriasis patients were compared to healthy controls (6-8).

Axial involvement has been reported by clinical or radiographic evidence in 25-70% of psoriasis patients with peripheral PsA (9-11). However, radiographs are insensitive for early recognition of axial inflammation as radiographic structural changes may only become apparent many years after symptom onset (12).
Furthermore, several studies have shown at best moderate reliability of radiographic evaluation of sacroiliitis according to the modified New York criteria (13, 14). Despite limitations of radiography, only few studies have investigated the presence of axial spondyloarthritis (SpA) in patients with PsA by using magnetic resonance imaging (MRI) (15-17). In these studies, MRI features were obtained in patients with symptomatic PsA or psoriasis-associated axial SpA. However, potential subclinical inflammation of the axial skeleton in patients with skin psoriasis, who lack clinical evidence of PsA, has not been addressed.

Based on previous observations of a high rate of subclinical inflammation in peripheral joints, we hypothesized whether MRI may also demonstrate features of subclinical axial involvement in patients with psoriasis manifestation restricted to the skin. Thus, the aim of this study was to explore potential subclinical inflammation of the axial skeleton by MRI of the SIJ and entire spine in patients with skin psoriasis but without clinical evidence of arthritis or spondylitis.

MATERIALS AND METHODS

Subjects

The study sample comprised 2 groups. The first group consisted of 20 patients with plaque-type skin psoriasis, but without self-reported or clinical evidence of peripheral or axial joint inflammation. Patients with skin psoriasis were recruited in the Dermatology outpatient clinic of Basel University Hospital over a period of
18 months. Patients with systemic or intraarticular therapy including corticosteroids, disease-modifying anti-rheumatic drugs or biologic agents within one year prior to enrolment were excluded. The second group consisted of 22 age and sex matched healthy controls. Exclusion criteria for controls were self-reported or clinical evidence of skin psoriasis, arthritis or inflammatory back pain. Age below 18 years, pregnancy, and long-term analgetic medication were exclusion criteria for both groups. The study protocol was approved by the local ethics review board and written informed consent was obtained from all subjects.

Clinical examination and laboratory tests

All patients and controls underwent clinical history taking and physical examination by the same dermatologist (PH) and the same rheumatologist (UAW) according to pre-defined standardized protocols. The dermatologic examination included the assessment of the psoriasis area and severity index (PASI) (18) and the body surface area involvement (BSA) (19). Patient history regarding back pain was collected using a doctor-administered questionnaire about prior or current inflammatory back pain, uveitis, dactylitis, and heel tenderness (20). The rheumatologic evaluation included 68 tender and 66 swollen peripheral joint counts, chest expansion, Schober, Ott and Mennell tests, and examination for dactylitis, uveitis and enthesitis (21-23). For study eligibility, all rheumatologic assessments had to be negative. Laboratory tests included erythrocyte sedimentation rate (ESR), C-reactive protein (CRP) and HLA-B27 status.
MRI protocol

All patients and controls underwent MRI of the SIJ and entire spine on a 1.5 T MR-scanner (Somatom Avanto, Siemens, Erlangen, Germany). The MRI protocol included coronal and sagittal T1-weighted turbo spin-echo (T1SE) and short-tau inversion recovery (STIR) sequences of the whole spine with a field of view 450 mm, slice thickness 5.0 or 3.0 mm and intersection gap 1.0 or 0.3 mm, for coronal or sagittal images, respectively. The parameters for the T1-weighted sequence were: repetition time (TR) 403-529 ms, echo time (TE) 10-11 ms, matrix 384x269 or 512x256 pixels, for coronal or sagittal images, respectively. For the STIR sequence the parameters were: TR 6270-10790 ms, TE 90-103 ms, inversion time (TI) 130 ms, matrix 384x269 or 448x269 pixels, for coronal or sagittal images, respectively. For the SIJ, coronal oblique T1-weighted turbo spin-echo and STIR sequences were acquired with a field of view 280 mm, slice thickness 4.0 mm and intersection gap 0.4 mm. The parameters for the T1-weighted sequence were: TR 450 ms, TE 11 ms, matrix 512x256 pixels, and for the STIR sequence: TR 4930 ms, TE 67 ms, TI 150 ms, matrix 256x256 pixels.

MRI evaluation

MR scans were evaluated in random order on dedicated workstations independently by a rheumatologist (UW) and a radiologist (VZ), who both had more than 10 years of scientific experience in imaging in SpA. The 2 readers had undergone pre-test calibration regarding lesion definitions and threshold in previous multicenter studies about diagnostic utility of MRI in axial SpA (24,
Readers were blinded to demographic and clinical data. The MR images of the SIJ and the entire spine were scored simultaneously for each study subject. Image analysis comprised two steps: first, a *global assessment* indicating presence or absence of SIJ inflammation based on contextual evaluation of all features on T1-weighted and STIR sequences of SIJ scans, and second *lesion-based* scores for pre-defined sacroiliac and spinal MRI features. All lesions according to standardized scoring modules (MORPHO module for the SIJ (26), CanDen module for the spine (27, 28)) were entered into a customized online data entry system described elsewhere (26).

**Global assessment of SIJ MRI**

Both readers indicated presence or absence of SIJ inflammation by contextual evaluation of all MRI features simultaneously on T1-weighted and STIR images of the SIJ. Confidence with this decision was assessed on a numeric rating scale ranging from 0-10, 0 indicating definitely no SIJ inflammation and 10 definitely SIJ inflammation. Subjects were classified as having SIJ inflammation if both readers independently agreed with a confidence of at least 5/5.

**Lesion-based assessment of SIJ and spine MRI**

For the SIJ, 4 pre-defined MRI lesion types were scored: bone marrow edema (BME), fat metaplasia (FM), erosion (ER) and ankylosis, according to standardized lesion definitions and SIJ MRI reference images of the MORPHO module (26). BME was defined as an increase in bone marrow signal in the SIJ.
on STIR images, fat metaplasia as a focal increased signal in bone marrow on T1SE images. For both lesion types, the center of the sacrum at the same craniocaudal level was used as the primary reference for normal bone marrow signal. We defined joint erosion as full-thickness loss of dark appearance of either iliac or sacral cortical bone of the SIJ and change in normal bright appearance of adjacent bone marrow on T1SE images; adjacent bone marrow demonstrates altered signal intensity on T1SE images as compared with normal iliac marrow (for iliac erosions) or normal sacral marrow (for sacral erosions) on the same slice at the same craniocaudal level. Ankylosis was defined as bright signal on T1SE images extending across the SIJ. Presence/absence of BME, FM and ER was recorded as binary variable in each quadrant (upper and lower ilium, upper and lower sacrum), ankylosis per upper and lower half of each SIJ on every slice across the cartilaginous joint compartment. The individually variable upper range of affected SIJ quadrants per subject is determined by the number of SIJ slices through the entire cartilaginous joint compartment, which is dependent on body size. In smaller framed subjects, the cartilaginous SIJ compartment is depicted by 5-6 slices, while 7-10 slices are needed in larger persons by standard MRI protocols applying 4 mm slice thickness. In an example of a person with 8 cartilaginous SIJ slices, the upper range of SIJ quadrants is 8 quadrants per slice multiplied with the individual slice number of 8, resulting in an upper range per subject over all 8 SIJ slices of 64.
Vertebral corner inflammatory lesions (CIL) and corner fat lesions (CFL) were recorded according to standardized lesion definitions following the CanDen module on central slices, i.e. slices located between the vertebral pedicles on both sides, for all 23 discovertebral units (DVU) from C2/3 to L5/S1 (27, 28). Anterior and posterior CIL and CFL were defined as increased signal in bone marrow at the vertebral corner in STIR and T1SE sequences, respectively, compared to the center of a normal vertebra. The total score range for vertebral corner lesions per subject and lesion type was 4 corner lesions times 23 DVU resulting in an upper score range of 92.

**Statistical analysis**

Disease characteristics are described using frequencies/percentages and means/standard deviations (SD) or medians/interquartile ranges (IQR) as appropriate. Under the assumption of an age dependent increase of degenerative axial lesions, patients and controls were dichotomized at the age of 50 years. Patients were additionally stratified according to duration of skin psoriasis adopting a threshold of 20 years. Characteristics of patients and healthy controls were compared using Wilcoxon-Mann-Whitney, Student’s t and \( \chi^2 \) tests.

The number of subjects concordantly classified by both readers as having SIJ inflammation by global assessment of SIJ MRI was calculated for patients and controls.

This article is protected by copyright. All rights reserved.
The lesion-based MRI scores were recorded separately for the SIJ and the spine as follows: for each subject, affected SIJ quadrants/halves were summed over all MRI slices for each lesion type, i.e. BME, FM, ER, and ankylosis, and vertebral CIL and CFL were summed over all DVUs. MRI scores were averaged across the 2 readers. We calculated the percentage of patients having ≥1/2/3/4/5 lesions as concordantly reported by both readers for each pre-defined lesion type.

Inter-rater reliability was assessed by Cohen’s Kappa or intra-class correlation coefficient of model 3 for single measurement (ICC(3,1)) and their 95% confidence intervals (95%CI), depending on the nature of the assessed variable. Kappa agreement was interpreted as slight: $\kappa<0.2$, fair: $0.2\leq\kappa<0.4$, moderate: $0.4\leq\kappa<0.6$, substantial: $0.6\leq\kappa<0.8$, and almost perfect: $0.8\leq\kappa<1$ (29). ICC(3,1) values ≥0.4, ≥0.6, ≥0.8, and ≥0.9 were regarded as representing moderate, good, very good, and excellent reproducibility, respectively (30). Data were analyzed using Stata/IC 15.1 (StataCorp, Texas, USA).

RESULTS

Characteristics of study subjects

Twenty skin psoriasis patients and 22 healthy controls were enrolled. Demographic, clinical, and laboratory data of both groups are summarized in Table 1. Fifty-five percent of patients and 45.5% of controls were male. Median duration of skin psoriasis was 23.0 years (IQR 10.0-34.3 years) without
statistically significant difference below or beyond age 50 years. All patients and controls were negative for the HLA-B27 allele.

The majority of patients displayed limited extent (BSA median 4.5, IQR 2.0-9.8) and low severity (PASI median 4.6, IQR 2.1-8.6) of skin psoriasis. Median chest expansion was 6.0 cm in both patients (IQR 5.0-7.0) and controls (IQR 5.0-6.8) (p=0.22). Median thoracic spine mobility by Ott test was 2.0 cm (IQR 1.0-3.0) in patients and 3.0 cm (IQR 2.0-3.0) in controls (p=0.06), and by Schober test 4.5 cm (IQR 3.3-5.0) in patients and 5.0 cm (IQR 4.4-5.0) in controls (p=0.10).

**Global assessment of SIJ MRI**

Inter-rater reliability for global assessment in the entire cohort was almost perfect with $\kappa=0.92$ (95%CI 0.76-1.00). By global assessment of SIJ MRI, 5 (25.0%) patients with skin psoriasis (Figure 1) and 2 (9.1%) controls (Figure 2) were concordantly classified by both readers as having SIJ inflammation (p=0.23, Table 2). Of these, 3 patients and 1 control were older than 50 years. Three patients classified as having SIJ inflammation had long-standing skin psoriasis, namely 26, 35 and 35 years. Two patients with skin psoriasis showed SIJ erosion and BME concordantly reported by both readers (SIJ scans of 1 patient depicted in Figure 1). The confidence levels of readers 1/2 for positive assignment of SIJ inflammation by reviewing simultaneously T1- and STIR sequences was moderate with 6/8 for these two skin psoriasis patients. The constellation of combined active and structural SIJ lesions proved a substantially higher specificity for sacroiliitis than by BME lesions alone (24).
The levels of confidence among the 2 readers for the 5 positive assignments of SIJ inflammation among skin psoriasis patients were 5/5, 6/8, 6/8, 8/9, and 8/5, among the 2 controls 7/7 and 6/9, respectively.

**Lesion-based assessment of SIJ and spine MRI**

For the SIJ the inter-rater reliability by ICC(3,1) was very good with 0.82 (95%CI 0.69-0.90) for BME, good with 0.69 (95%CI 0.49-0.82) for FM, and moderate with 0.44 (95%CI 0.16-0.65) for ER. The prevalence of sacroiliac MRI changes was similar in patients and healthy controls for all lesion types (all p>0.1, Table 3). The median of affected SIJ quadrants in patients was 0.5 for BME and FM, respectively, and 0.0 for ER. In controls the medians were 0.8 for BME and 0.0 for FM and ER, respectively. No SIJ ankylosis was recorded in either group. There was no difference between age groups regarding prevalence of any lesion type in patients and controls.

For the spine, inter-rater reliability by ICC(3,1) was good with 0.78 (95%CI 0.64-0.88) for CIL and excellent with 0.94 (95%CI 0.88-0.96) for CFL. Spinal lesions had a similar prevalence in patients and controls with medians of 1.0 and 0.5 CIL, and 0.3 and 0.0 CFL, respectively (Table 3). Dichotomization by age showed an increase in prevalence of CIL (p=0.002) beyond age 50 years in patients. In controls, differences between age groups for CIL and CFL were not statistically significant.
The numbers of subjects having ≥1/2/3/4/5 affected SIJ quadrants or spine lesions for the various lesion types, as concordantly recorded by both readers are shown in Table 4. There was no statistically significant difference between patients and controls for any of the 5 levels of lesion frequency (all p>0.2). A threshold of less than 10% of controls having a given SIJ lesion was met by ≥5 SIJ quadrants with BME and by 0 erosion. Both spinal lesion types were concordantly reported more frequently in the older age group above 50 years.

DISCUSSION

Subclinical peripheral joint inflammation detected by MRI has been reported as a common finding in patients with skin psoriasis and no clinical evidence of PsA (5). In our controlled study, patients with skin psoriasis without clinical signs of arthritis or spondylitis showed limited evidence of concomitant subclinical axial inflammation by MRI of the SIJ and entire spine. A numerically slightly higher proportion of 25% of patients with longstanding skin psoriasis and 9% of healthy controls were concordantly classified by both readers as having SIJ inflammation (p=0.23). Among patients with skin psoriasis, 2 individuals simultaneously showed SIJ erosion and BME contributing to an assignment of potential subclinical SIJ inflammation. However, frequencies of edematous and structural axial lesions were comparable and did not differ significantly between patients and controls, both on SIJ and spine MRI. These findings do not support routine screening for potential subclinical axial inflammation in patients with longstanding skin psoriasis.
We observed at least 2 SIJ quadrants with BME lesions in 35% of psoriasis patients and 23% of healthy controls. The findings in our study sample do not differ substantially from those recorded in healthy individuals of previous reports. Weber et al. found at least 2 SIJ BME lesions in 30% of healthy controls (24). If a specificity threshold for a given MRI lesion of at least 0.9 is applied for axial MRI to discriminate between axial SpA and background variation in healthy controls or in differential diagnostic conditions, no more than 10% of healthy controls in our study should meet this criterion by an individual level data analysis. Table 4 shows that a minimum of 5 SIJ quadrants affected by BME is needed to reach a specificity of ≥ 0.9, because the proportion of healthy controls lies only at a threshold of 5 BME lesions below 10% (9.1%). This finding is consistent with another study in healthy individuals, which found the same threshold of ≥5 SIJ quadrants with BME using the same MRI assessment module (31).

Presence of BME lesions meeting the ASAS criteria for sacroiliitis were reported in 35-40% of healthy young individuals with high axial strain. The proportions in military recruits upon 6 weeks of intense physical training and in elite ice-hockey players at the end of the competitive season fulfilling the ASAS definition as concordantly recorded by at least 2 out of 3 readers were 36% and 41%, respectively (32, 33). Reasons may be manifold for the common finding of BME signals in the SIJ of healthy individuals with or without regular physical activity. Potential explanations to consider are mechanical stress injury to the axial skeleton, degenerative SIJ changes, anatomical SIJ variants or partial volume averaging from vascular signals. Our study highlights the importance of an appropriate control group when exploring axial lesions by MRI in
inflammatory conditions (Figure 2). Controls help minimize overcalling seemingly positive assignments in patients with longstanding skin psoriasis by providing an estimate of “background noise” for various MRI lesion types.

In our study, the impact of age on lesion frequency was more noticeable in spinal than in sacroiliac inflammatory lesions. The frequency of psoriasis patients having CIL showed a statistically significant increase in patients above 50 years of age compared with spine MRI obtained in younger patients. This observation supports the hypothesis, that some spinal alterations in higher age may reflect degenerative rather than inflammatory changes (34). However, there is a gap in knowledge with virtually no evidence about presence and pattern of degenerative versus inflammatory spinal lesions in subjects beyond 50 years of age.

For most lesion types there was substantial agreement between the 2 independent readers. For the SIJ, interrater agreement was very good for BME and good for FM, consistent with previous reports (35-37). The moderate interrater reliability for ER relates to the very low prevalence of erosion in both groups (no erosion in healthy controls, only 2 patients with at least 1 erosion), as opposed to earlier reports in cohorts with established axial SpA showing frequent erosion and high inter-reader reproducibility (36, 37). The interrater reliability for spinal lesions ranged from good to excellent, in keeping with or even superior to agreement data in previous reports (25).

Several hypotheses might explain why patients in our study with skin psoriasis but without clinical arthritis or spondylitis did not show MRI evidence for subclinical axial inflammation. Psoriatic skin and joint disease is regarded as a
heterogeneous clinical spectrum with a variety of different genetic signatures (3, 38). Previous studies have identified an association between HLA-B27 carrier status and more severe disease course of axial PsA (15, 39). Although HLA-B27 positivity was not an eligibility criterion, our study subjects comprised only HLA-B27 negative psoriasis patients and healthy controls. Furthermore, prior reports on genetic determinants other than HLA-B27 suggested that HLA-C*06 allele is associated with delayed onset PsA and reduced risk for axial involvement (3, 38, 40). PsA is known to have a stronger association with severe skin disease and specific skin locations such as scalp or nail involvement (41, 42). The patients in our study sample had no systemic treatment and displayed low severity skin disease as expressed by PASI, which may have contributed to a minor risk of axial inflammation.

Our study has various limitations. Conclusions are drawn from a small study sample, which may preclude finding a true difference between groups. The lack of HLA-B27 positive individuals as well may be related to the small sample size. Our patient sample was heterogeneous with respect to disease duration, which ranged from 4 to 43 years. This heterogeneity might also be considered as a strength for generalizing the results to a larger population, but longer duration of skin disease has been shown to be associated with more frequent peripheral joint involvement (9, 11, 43). Finally, the psoriasis patients were not followed prospectively to explore potential development of clinical PsA.

In conclusion, our controlled study in patients with skin psoriasis, but without clinical signs of arthritis or spondylitis showed limited evidence for concomitant subclinical axial inflammation by MRI of the SIJ and entire spine. Our findings
do not advocate screening for subclinical axial inflammation by MRI in patients who have psoriasis activity clinically limited to the skin.

AUTHOR CONTRIBUTIONS

All authors were involved in drafting the article or revising it critically for important intellectual content, and all authors approved the final version to be published. Bratu VA had full access to all of the data in the study and takes responsibility for the integrity of the data and the accuracy of the data analysis.

Study conception and design: Bratu VA, Häusermann P, Walker UA, Daikeler T, Studler U

Acquisition of data: Bratu VA, Häusermann P, Walker UA, Daikeler T, Zubler V, Weber U, Studler U


ACKNOWLEDGEMENTS

The authors thank the patients and healthy volunteers for their participation; Tanja Haas (MRI technician, Department of Radiology, University Hospital Basel) for technical support and the performance of the MRI scans.

This article is protected by copyright. All rights reserved.
REFERENCES


27. Lambert RGW, Pedersen SJ, Maksymowych WP, Chiowchanwisawakit P, Ostergaard M. Active inflammatory lesions detected by magnetic resonance


Table 1. Demographic and clinical characteristics of study subjects

<table>
<thead>
<tr>
<th>Psoriasis patients</th>
<th>Healthy controls</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>All</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(n=20)</td>
</tr>
<tr>
<td>Male:female; n</td>
<td>11:9</td>
</tr>
<tr>
<td>(% male)</td>
<td>(55.0)</td>
</tr>
<tr>
<td>Age (years)</td>
<td>48.5</td>
</tr>
<tr>
<td></td>
<td>(42.3-58.8)</td>
</tr>
<tr>
<td>Duration of psoriasis (years)</td>
<td>23.0</td>
</tr>
<tr>
<td></td>
<td>(10.0-34.3)</td>
</tr>
<tr>
<td></td>
<td>4.5</td>
</tr>
<tr>
<td>------------------</td>
<td>-------</td>
</tr>
<tr>
<td>BSA (%)</td>
<td>4.5</td>
</tr>
<tr>
<td>PASI</td>
<td>4.6</td>
</tr>
<tr>
<td>HLA B27; n</td>
<td>0</td>
</tr>
<tr>
<td>ESR (mm/h)</td>
<td>6.0</td>
</tr>
<tr>
<td>CRP (mg/l)</td>
<td>1.6</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Values are medians (IQR) unless otherwise stated. BSA: body surface area involvement. CRP: C-reactive protein; ESR: erythrocyte sedimentation rate; HLA B27: human leucocyte antigen B27; IQR: interquartile range; n/a: not applicable. PASI: psoriasis area and severity index.
Table 2. Subjects classified as having SIJ inflammation by 2 readers concordantly by global assessment of SIJ MRI

<table>
<thead>
<tr>
<th></th>
<th>Psoriasis patients</th>
<th></th>
<th></th>
<th></th>
<th>Healthy controls</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>All</td>
<td>Age ≤50 years</td>
<td>Age &gt;50 years</td>
<td>Psoriasis ≤20 years</td>
<td>Psoriasis &gt;20 years</td>
<td>All</td>
<td>Age ≤50 years</td>
</tr>
<tr>
<td></td>
<td>(n=20)</td>
<td>(n=11)</td>
<td>(n=9)</td>
<td>(n=10)</td>
<td>(n=10)</td>
<td>(n=22)</td>
<td>(n=14)</td>
</tr>
<tr>
<td>n (%)</td>
<td>5 (25.0)</td>
<td>2 (18.2)</td>
<td>3 (33.3)</td>
<td>2 (20.0)</td>
<td>3 (30.0)</td>
<td>2 (9.1)</td>
<td>1 (7.1)</td>
</tr>
<tr>
<td>Mean confidence (SD)</td>
<td>6.8 (1.3)</td>
<td>7.5 (1.4)</td>
<td>6.3 (1.2)</td>
<td>7.8 (1.1)</td>
<td>6.2 (1.0)</td>
<td>7.3 (0.4)</td>
<td>7.5 (n/a)</td>
</tr>
</tbody>
</table>

Confidence with classification of SIJ inflammation ranging from 0 (definitely no inflammation) to 10 (definitely inflammation) across 2 readers. n/a: not applicable (n=1); SIJ: sacroiliac joints; SD: standard deviation;
Table 3. Frequency of MRI lesions in the SIJ and the spine

<table>
<thead>
<tr>
<th>Location and type of MRI lesion</th>
<th>Psoriasis patients</th>
<th>Healthy controls</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>All</td>
<td>Age ≤50 years</td>
</tr>
<tr>
<td></td>
<td>(n=20)</td>
<td>(n=11)</td>
</tr>
<tr>
<td>BME</td>
<td>0.5 (0.0-3.4)</td>
<td>0.0 (0.0-6.5)</td>
</tr>
<tr>
<td>FM</td>
<td>0.5 (0.0-3.5)</td>
<td>0.0 (0.0-3.5)</td>
</tr>
<tr>
<td>SIJ quadrants</td>
<td>0.0 (0.0-0.5)</td>
<td>0.0 (0.0-1.0)</td>
</tr>
<tr>
<td>ER</td>
<td>0.0 (0.0-0.0)</td>
<td>0.0 (0.0-0.0)</td>
</tr>
<tr>
<td>ANK</td>
<td>0.0 (0.0-0.0)</td>
<td>0.0 (0.0-0.0)</td>
</tr>
<tr>
<td>Vertebral corner</td>
<td>1.0 (0.1-5.5)</td>
<td>0.5 (0.0-1.0)</td>
</tr>
</tbody>
</table>

This article is protected by copyright. All rights reserved.
<table>
<thead>
<tr>
<th>lesions</th>
<th>CFL</th>
<th>0.3</th>
<th>0.0</th>
<th>0.5</th>
<th>0.3</th>
<th>0.3</th>
<th>0.0</th>
<th>0.0</th>
<th>1.0</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>(0.0-1.4)</td>
<td>(0.0-1.0)</td>
<td>(0.0-7.8)</td>
<td>(0.0-1.8)</td>
<td>(0.0-1.6)</td>
<td>(0.0-2.0)</td>
<td>(0.0-1.5)</td>
<td>(0.3-3.8)</td>
</tr>
</tbody>
</table>

Values are score medians (IQR) of affected SIJ quadrants and vertebral corner lesions averaged across the scores of the 2 readers.

ANK: ankylosis; BME: bone marrow edema; CFL: corner fat lesion; CIL: corner inflammatory lesion; ER: erosion; FM: fat metaplasia;
IQR: interquartile range; SIJ: sacroiliac joints.
Table 4. Frequency of subjects with MRI lesions scored concordantly by both readers in the SIJ and the spine

<table>
<thead>
<tr>
<th>Location and type of MRI lesion</th>
<th>Psoriasis patients</th>
<th></th>
<th>Healthy controls</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>All (n=20)</td>
<td>Age ≤50 years (n=11)</td>
<td>Age &gt;50 years (n=9)</td>
<td>Psoriasis ≤20 years (n=10)</td>
</tr>
<tr>
<td>BME</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>≥1</td>
<td>7 (35.0)</td>
<td>3 (27.3)</td>
<td>4 (44.4)</td>
<td>4 (40.0)</td>
</tr>
<tr>
<td>≥2</td>
<td>7 (35.0)</td>
<td>3 (27.3)</td>
<td>4 (44.4)</td>
<td>4 (40.0)</td>
</tr>
<tr>
<td>≥3</td>
<td>6 (30.0)</td>
<td>3 (27.3)</td>
<td>3 (33.3)</td>
<td>3 (30.0)</td>
</tr>
<tr>
<td>≥4</td>
<td>4 (20.0)</td>
<td>3 (27.3)</td>
<td>1 (11.1)</td>
<td>2 (20.0)</td>
</tr>
<tr>
<td>≥5</td>
<td>4 (20.0)</td>
<td>3 (27.3)</td>
<td>1 (11.1)</td>
<td>2 (20.0)</td>
</tr>
<tr>
<td>FM</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>≥1</td>
<td>3 (15.0)</td>
<td>2 (18.2)</td>
<td>1 (11.1)</td>
<td>1 (10.0)</td>
</tr>
<tr>
<td>≥2</td>
<td>3 (15.0)</td>
<td>2 (18.2)</td>
<td>1 (11.1)</td>
<td>1 (10.0)</td>
</tr>
<tr>
<td>≥3</td>
<td>2 (10.0)</td>
<td>2 (18.2)</td>
<td>0 (0.0)</td>
<td>1 (10.0)</td>
</tr>
<tr>
<td>≥4</td>
<td>1 (5.0)</td>
<td>1 (9.1)</td>
<td>0 (0.0)</td>
<td>1 (10.0)</td>
</tr>
<tr>
<td>≥5</td>
<td>1 (5.0)</td>
<td>1 (9.1)</td>
<td>0 (0.0)</td>
<td>1 (10.0)</td>
</tr>
<tr>
<td>ER</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>≥1</td>
<td>2 (10.0)</td>
<td>1 (9.1)</td>
<td>1 (11.1)</td>
<td>1 (10.0)</td>
</tr>
<tr>
<td>≥2</td>
<td>1 (5.0)</td>
<td>0 (0.0)</td>
<td>1 (11.1)</td>
<td>0 (0.0)</td>
</tr>
<tr>
<td>≥3</td>
<td>1 (5.0)</td>
<td>0 (0.0)</td>
<td>1 (11.1)</td>
<td>0 (0.0)</td>
</tr>
<tr>
<td>≥4</td>
<td>1 (5.0)</td>
<td>0 (0.0)</td>
<td>1 (11.1)</td>
<td>0 (0.0)</td>
</tr>
</tbody>
</table>
Values are numbers of study subjects (percentage) with MRI lesions scored concordantly by both readers. BME: bone marrow edema; CFL: corner fat lesion; CIL: corner inflammatory lesion; ER: erosion; FM: fat metaplasia; SIJ: sacroiliac joints.
FIGURE LEGENDS

Figure 1. Semicoronal STIR (A) and T1-weighted (B) images of the sacroiliac joints in a 21-year-old female patient with skin psoriasis.

(A) STIR image shows poorly defined subchondral bone marrow edema in the left iliac bone (arrow).

(B) T1-weighted image located one slice posterior to image A demonstrates an erosion (curved arrows) with surrounding fat metaplasia in the left sacrum (arrow).

Figure 2. Semicoronal STIR (A) and T1-weighted (B) images of the sacroiliac joints in a 51-year-old male healthy control.

(A) STIR image illustrates subchondral bone marrow edema in the cartilaginous compartment of the left sacroiliac joint (arrow).

(B) The corresponding T1-weighted image shows poorly defined left iliac cortical bone (arrows) mimicking an erosion at the margin of bone marrow edema visible on the STIR sequence.