EXTENDED REPORT

Axial Disease in Psoriatic Arthritis study: defining the clinical and radiographic phenotype of psoriatic spondyloarthritis

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ABSTRACT

Objectives To compare the prevalence, clinical and radiographic characteristics of psoriatic spondyloarthritis (PsSpA) in a Psoriatic Arthritis (PsA) cohort; to compare the clinical features of PsSpA with both PsA and Ankylosing Spondylitis (AS); (2) compare the clinical characteristics of PsSpA with both PsA and AS; (3) compare the radiographic axial characteristics of PsSpA with both PsA and AS.

Methods A prospective single-centre cross-sectional observational study recruited consecutive PsA and AS cases. Participants completed outcome measures, and underwent clinical examination, radiographic scoring and HLA-sequencing. Multivariable analyses are presented.

Results The 402 enrolled cases (201 PsA, 201 AS; fulfilling classification criteria for respective conditions) were reclassified based upon radiographic axial disease and psoriasis, as: 118 PsSpA, 127 peripheral-only PsA (pPsA), and 157 AS without psoriasis (AS) cases. A significant proportion of patients with radiographic axial disease had PsSpA (118/275; 42.91%), and often had symptomatically silent axial disease (30/118; 25.42%). Modified New York criteria for AS were fulfilled by 48/201 (23.88%) PsA cases, and Classification of Psoriatic Arthritis criteria by 49/201 (24.38%) AS cases. pPsA cases fulfilled New York criteria for both conditions. The pattern of axial disease was more severe in AS than in PsSpA, as measured by the Bath AS Radiology Index, and quality of life are reported to be no different in AS and PsSpA.

Conclusions In a combined cohort of patients with either PsA or AS from a single centre, 24% fulfilled classification criteria for both conditions. The pattern of axial disease was influenced significantly by the presence of skin psoriasis and HLA-B*27.

INTRODUCTION

Psoriatic spondyloarthritis (PsSpA) is a term that can be used for spondyloarthritides (SpA) accompanying psoriasis. PsSpA shares features of both psoriatic arthritis (PsA) and ankyllosing spondylitis (AS).1–17 including axial arthritis, peripheral arthritis and enthesitis. Only four studies have compared the clinical characteristics of PsSpA and AS.7 9 11 14 with the following reported to have worse scores in AS compared with PsSpA: metrorolgy,14 occiput to wall distance,14 and Schober’s test of lumbar forward flexion.7 9 14 Composite indices of disease activity (Bath AS Disease Activity Index; BASDAI),16 function (Bath AS Functional Index; BASFI) and quality of life11 are reported to be no different in AS and PsSpA.

Only four studies have compared the axial radiographic characteristics of PsSpA and AS.2 7 9 11 Sacroiliitis appears to be commonly bilateral in AS (even in early disease), but either unilateral or bilateral in PsSpA.2 While Gladman et al demonstrated a higher frequency of grade 4 sacroiliitis in AS compared with PsSpA, the findings were not corroborated in another study.9 In AS, syndesmophytes have been shown to be symmetrically distributed.2 9 progressing caudal to cranial, and with a primarily marginal rather than paramarginal shape.2 In PsSpA, syndesmophytes appear to progress randomly along the spine,2 9 with equal frequency of marginal and paramarginal syndesmophytes.2 9 Radiographic severity appears to be worse in AS than in PsSpA, as measured by the Bath AS Radiology Index.11 11 and number of syndesmophytes.

Since the findings of these studies have not been entirely consistent, we sought to: (1) determine the prevalence of PsSpA in a spondyloarthritides (PsA and AS) cohort; (2) compare the clinical characteristics of PsSpA with both PsA and AS; (3) compare the radiographic axial characteristics of PsSpA with both PsA and AS.

METHODS

A prospective single-centre cross-sectional observational study (Axial Disease in Psoriatic Arthritis study) was conducted (2012–2013) at a secondary care teaching hospital attended by 600 patients with PsA and 750 patients with AS for ongoing clinical care. Consecutive patients, aged ≥18 years, attending dedicated PsA and AS clinics were invited to participate, aiming to enrol 200 PsA and 200 AS cases. Study inclusion criteria included either: a diagnosis of PsA fulfilling the Classification of Psoriatic Arthritis (CASPAR) criteria18 19 in those attending the PsA clinic; or a diagnosis of AS

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fulfilling the 1987 modified New York (mNY) diagnostic criteria for AS\textsuperscript{20} in those attending the AS clinic.

**Clinical assessment**
Participants completed patient reported outcome measures validated for use in PsSpA, including: BASDAI,\textsuperscript{21–23} BASFI,\textsuperscript{14, 24} Health Assessment Questionnaire Disability Index (HAQ),\textsuperscript{25, 26} and Ankylosing Spondylitis Disease Activity Score (ASDAS).\textsuperscript{22, 23, 27} Participants were questioned by a rheumatologist (DRJ) for a current or past history of: inflammatory axial symptoms (Assessment of Spondyloarthritis Society definition\textsuperscript{28}); extra-articular manifestations including dactylitis, peripheral enthesitis, chest wall pain, uveitis and inflammatory bowel disease (IBD); family history in first-degree relatives of SpA, psoriasis, uveitis and IBD; tobacco smoking; synthetic TNF antagonist (anti-TNF) use; biologic DMARD use; age at psoriasis symptom onset and diagnosis; and age at arthritis symptom onset and diagnosis. Data were verified using case notes.

All participants were examined by a rheumatologist (DRJ) using these clinical examination indices: Bath Ankylosing Spondylitis Metrology Index (BASMI),\textsuperscript{29} chest expansion, Leeds Enthesitis Index (LEI),\textsuperscript{30} 68 tender joint count,\textsuperscript{31} 66 swollen joint count (SJC),\textsuperscript{31} Psoriasis Area and Severity Index (PASI),\textsuperscript{32} modified Nail Psoriasis Severity Index (mNAPSI),\textsuperscript{33} and body mass index (BMI).\textsuperscript{34}

**Laboratory testing**
Blood samples were taken for HLA-B typing and high-sensitivity C reactive protein testing. All subjects were typed for HLA-B alleles by a Sanger sequence-based method,\textsuperscript{35} except that the PCR reactions were carried out using a nested two-stage method,\textsuperscript{35} involving the heterozygous amplification of exon-2, intron-2 and exon-3 of HLA-B and HLA-C. Allele assignment was performed using SeqScape software (V.2.5; Applied Biosystems) and a library compiled from the current ImMunoGeneTics database.\textsuperscript{36} Allele designations are those recommended by the WHO nomenclature committee, and which separates locus, allelic group and allelic type by an asterisk and colons.\textsuperscript{36} Allele frequencies were directly enumerated.

**Axial radiographic scoring**
In keeping with previous publications,\textsuperscript{37, 38} inflammatory radiographic axial disease (RAD) was defined in PsSpA cases as the presence of: New York criteria sacroiliitis (unilateral grade ≥3 or bilateral grade ≥2 sacroiliitis on pelvic radiograph) and/or ≥1 marginal/paramarginal syndesmophyte(s) of the cervical and/or lumbar spine.

The most recent axial radiographs of all participants were scored, blinded to clinical diagnosis, using two validated axial radiographic scoring tools for PsA; the Psoriatic Arthritis Spondylitis Radiology Index (PASRI)\textsuperscript{19} and the modified Stoke Ankylosing Spondylitis Spinal Score (mSASSS).\textsuperscript{40} The hospital’s clinical protocol ensures that all PsA and AS cases have plain radiographs of their cervical spine (lateral in extension), lumbar spine (anteroposterior and lateral) and pelvis (anteroposterior) performed at least once during their care. Therefore radiographs were not at fixed time points relative to the research assessment. Studies in AS report a very slow rate of axial radiographic progression (mean 1.3 unit/year; SD 2.5).\textsuperscript{41} As no data exist for PsSpA, a pilot study was undertaken to estimate this rate in PsSpA. Sequential axial radiographs were scored of 22 patients with PsSpA attending the hospital over a period spanning 2–31 years. mSASSS progression in PsSpA was only 0.6 units/year, justifying the use of historic radiographs (≤10 years old) with prospective clinical data in this study.

**Axial radiographic scoring reliability exercise and reading strategy**
Two raters (DRJ and AN) underwent training in axial radiographic scoring by an experienced consultant musculoskeletal radiologist (GR). A broad-based horizontal morphology with adjacent degenerative features (intervertebral disc degeneration and/or end plate changes) were deemed to be a degenerative osteophyte. A thorn-like angulated morphology without adjacent degenerative features was deemed to be an inflammatory syndesmophyte. Ten random cases (five PsA, five AS) were selected from the cohort and scored independently by DRJ, AN and GR (the ‘gold-standard’ rater) using the PASRI and mSASSS, to assess inter-rater reliability. The same 10 cases were scored again a month later to assess intrarater reliability. Axial radiographs of the cohort were scored by two raters (DRJ and AN) using the PASRI and mSASSS. All equivocal cases were discussed with GR before final classification.

**Statistical analysis**
Data were analysed using STATA V.12.1 (2011 Texas, USA). Inter-rater and intrarater reliability was tested using the intraclass correlation coefficient (ICC). Univariable and multivariable analyses were performed using the χ² test, independent Student’s t-test, Mann-Whitney U test, logistic regression, linear regression, Poisson regression for non-normally distributed count data, and zero-inflated Poisson regression for non-normally distributed count data with an excess of zero values, as appropriate. Reverse stepwise regression was used to adjust for significant covariates, including: sex; age and disease duration at clinical assessment; age and disease duration at radiographic assessment; current or past history of sDMARD use, antitumour necrosis factor-α (anti-TNF) use and smoking; BMI and HLA-B*27 status. The α-level for statistical significance was 0.05.

**Ethical considerations**
The study was performed with ethical approval by Frenchay Regional Ethics Committee, written consent from participants, and in accordance with the Declaration of Helsinki.

**RESULTS**
The study enrolled 402 participants (201 PsA, 201 AS) and there were no missing clinical data. Complete axial radiographs were available for 392/402 (97.5%) participants; 10 PsA cases with incomplete radiographs to determine RAD, were assumed to have peripheral-only PsA (pPsA). The participants were reclassified as: PsSpA (n=118; 29.35%) based upon psoriasis (past/present) and RAD; pPsA (n=127; 31.60%) based upon psoriasis (past/present), peripheral arthritis and no RAD; and AS (n=157; 39.05%) based upon mNY criteria for AS\textsuperscript{20} and no psoriasis (past/present). A substantial proportion of patients with RAD had PsSpA (118/275; 42.91%).

**Fulfilment of CASPAR, mNY and ASAS criteria**
Forty-eight of 201 (23.88%) participants with PsA attending the PsA clinic (all fulfilling CASPAR) also fulfilled mNY criteria for AS. Forty-nine of 201 (24.38%) participants with AS attending the AS clinic (all fulfilling mNY criteria) also fulfilled CASPAR criteria for PsA. Although a lack of MRI data prevented us from fully applying the ASAS classification for axial SpA across our cohort, we did find that 157/157 (100%) of AS cases, 85/118
(72%) of PsSpA cases and 9/127 (7%) of pPsA cases fulfilled ASAS criteria for axial SpA by either or both clinical-only or radiographic imaging streams.

**Sociodemographic, treatment, laboratory and genetic characteristics**
PsSpA, pPsA and AS cases were broadly similar in terms of age, disease duration, treatment and other sociodemographic characteristics (tables 1 and 2). Any differences were adjusted for in the multivariable models. HLA-B*27 alleles (mainly HLA-B*27:05:02) were present in 9/127 (7.09%) pPsA, 47/118 (39.83%) PsSpA and 140/157 (89.17%) AS cases (table 1). Compared with PsSpA cases, the presence of HLA-B*27 was significantly more likely in AS (OR 12.44; 95% CI 6.67 to 23.22, p<0.001) and significantly less likely in pPsA (OR 0.12; 95% CI 0.05 to 0.25, p<0.001).

**Clinical predictors of PsSpA occurrence in PsA cases**
Compared with pPsA cases, PsSpA cases had significantly younger age at arthritis symptom onset (median 37.98 years vs 31.27 years, p=0.01) (table 2). Male PsA cases were no more likely than female cases to have PsSpA (adjusted OR, ORadj 1.48; 95% CI 0.87 to 2.52, p=0.18).

**Patient-reported outcome measures**
A history (past/present) of inflammatory axial symptoms was present in 77/127 (60.63%) pPsA, 88/118 (74.58%) PsSpA and 156/157 (99.36%) AS cases (table 3). Of note, 30/118 (25.42%) pPsA cases were significantly less likely to have a history of IBD than PsSpA cases (ORadj 0.12; 95% CI 0.03 to 0.55, p=0.01) (table 3). AS cases were significantly less likely to have a history of dactylitis than PsSpA cases (ORadj 0.18; 95% CI 0.07 to 0.42, p<0.001). Family history of SpA, psoriasis, uveitis and IBD were no different between groups.

**Composite clinical indices**
Disease activity, as measured by ASDAS, was frequently high (2.1–3.4) or very high (≥3.5) in both PsSpA (64/118; 54.24%) and AS (80/157; 50.96%), with no statistically significant difference between diseases. Similarly, in both PsSpA and AS cases, BASDAI indicated active (≥3.5 units\(^2\)) disease (median 3.60 vs 3.20), with no significant statistical (adjusted incidence risk ratio, IRRadj, 1.03; 95% CI 0.92 to 1.17) or clinical (minimum clinically important difference, MCID of 1 unit in AS\(^4\)) difference between diseases. Patient global assessment of axial disease activity (PaGA) in both PsSpA and AS indicated active (≥24 cm) disease, with no statistically significant differences between diseases (median 3 cm vs 3 cm).

Function, as measured by the BASFI, was poorer in AS compared with PsSpA (median 3.90 vs 3.10), with a clinically significant (MCID 0.7 units in AS\(^4\)) and a statistically significant difference between diseases (IRRadj, 1.14 to 1.99; 95% CI 1.05 to 2.17). Similarly, in both PsSpA and AS cases, BASMI and its subdomains and chest expansion were no different between groups. Other BASMI subdomains and chest expansion were no different between groups.

**Clinical examination indices**
Nail disease severity, measured using the mNAPSI, was significantly lower in pPsA than PsSpA (IRRadj, 0.90 per unit increase; 95% CI 0.83 to 0.97, p=0.01). More specifically, nail onycholysis severity was significantly lower in pPsA than PsSpA (IRRadj, 0.84 per unit increase; 95% CI 0.74 to 0.95, p=0.01). pPsA and PsSpA were no different in terms of SJC, enthesitis severity (LEI) or psoriasis severity (PSI). Enthesitis severity (LEI) was higher in AS than PsSpA (IRRadj, 1.33; 95% CI 1.02 to 1.74, p=0.04).

**Axial metrology**
Axial metrology measured using the BASMI was no different in AS and PsSpA (IRRadj, 1.07 per unit increase; 95% CI 0.95 to 1.21). However, tragus to wall distance (adjusted mean difference -2.00 cm; 95% CI 0.58 to 3.42, p=0.006) and modified Schober’s test (adjusted mean difference -0.63 cm; 95% CI -1.14 to -0.15, p=0.01) were poorer in AS than in PsSpA cases. Other BASMI subdomains and chest expansion were no different in PsSpA and AS. Surprisingly, BASMI and its subdomains were no different in PsSpA and pPsA cases.

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**Table 1** Sociodemographic, genetic and treatment characteristics of the PsSpA (n=127), AS (n=157) and pPsA (n=118) cases (categorical variables)

<table>
<thead>
<tr>
<th></th>
<th>PsSpA n (%)</th>
<th>AS n (%)</th>
<th>pPsA n (%)</th>
<th>AS versus PsSpA</th>
<th>pPsA versus PsSpA</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>OR</td>
<td>95% CI</td>
<td>p Value</td>
<td>OR</td>
<td>95% CI</td>
</tr>
<tr>
<td>Men</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Caucasian ancestry</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>patient-reported</td>
<td>74 (63)</td>
<td>118 (75)</td>
<td>66 (52)</td>
<td>1.80</td>
<td>1.07 to 3.03</td>
</tr>
<tr>
<td></td>
<td>1.00</td>
<td>1.07</td>
<td>3.03</td>
<td>0.03</td>
<td>1.00</td>
</tr>
<tr>
<td>HLA-B*27 presence</td>
<td>117 (99)</td>
<td>156 (99)</td>
<td>127 (100)</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td></td>
<td>0.79</td>
<td>0.83</td>
<td>1.00</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>Smoking ever</td>
<td>47 (40)</td>
<td>140 (89)</td>
<td>9 (7)</td>
<td>12.44</td>
<td>6.67 to 23.22</td>
</tr>
<tr>
<td></td>
<td>0.12</td>
<td>0.05</td>
<td>0.25</td>
<td>&lt;0.001</td>
<td>0.12</td>
</tr>
<tr>
<td>Synthetic DMARD use</td>
<td>53 (45)</td>
<td>26 (17)</td>
<td>83 (65)</td>
<td>0.24</td>
<td>0.14 to 0.42</td>
</tr>
<tr>
<td>ever</td>
<td>2.33</td>
<td>1.39</td>
<td>3.85</td>
<td>0.001</td>
<td>2.33</td>
</tr>
<tr>
<td>Anti-TNF use ever</td>
<td>53 (45)</td>
<td>59 (38)</td>
<td>47 (37)</td>
<td>0.74</td>
<td>0.45 to 1.20</td>
</tr>
<tr>
<td></td>
<td>0.72</td>
<td>0.43</td>
<td>1.22</td>
<td>0.21</td>
<td>0.72</td>
</tr>
</tbody>
</table>

*Continuity adjusted \( \chi^2 \) test.
Anti-TNF, antitumour necrosis factor; AS, ankylosing spondylitis.
DMARD, disease modifying antirheumatic drug; HLA, human leucocyte antigen; n, number/proportion; pPsA, peripheral psoriatic arthritis; PsSpA, psoriatic spondylarthropathy.

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Clinical and epidemiological research

Table 2  Sociodemographic and laboratory characteristics of the PsSpA (n=118), AS (n=157) and pPsA (n=127) cases (numerical variables)

<table>
<thead>
<tr>
<th></th>
<th>PsSpA Median (IQR)</th>
<th>AS Median (IQR)</th>
<th>pPsA Median (IQR)</th>
<th>AS versus PsSpA Mean diff (95% CI)</th>
<th>p Value</th>
<th>pPsA versus PsSpA Mean diff (95% CI)</th>
<th>p Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (years)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Clinical assessment</td>
<td>58.09 (11.42)</td>
<td>53.44 (13.61)</td>
<td>58.13 (11.71)</td>
<td>−4.63 (−7.68 to −1.58)</td>
<td>0.003*</td>
<td>−0.03 (−2.95 to 2.88)</td>
<td>0.98*</td>
</tr>
<tr>
<td>Arthritis onset</td>
<td>31.27 (21.06, 46.24)</td>
<td>20.00 (16.00, 26.00)</td>
<td>37.98 (28.37, 46.32)</td>
<td>−</td>
<td></td>
<td>−</td>
<td></td>
</tr>
<tr>
<td>Arthritis diagnosis</td>
<td>35.99 (27.27, 52.00)</td>
<td>29.00 (23.00, 38.00)</td>
<td>39.99 (29.70, 48.73)</td>
<td>−</td>
<td></td>
<td>−</td>
<td></td>
</tr>
<tr>
<td>Psoriasis onset</td>
<td>31.50 (17.50, 41.50)</td>
<td>−</td>
<td>27.00 (16.00, 14.00)</td>
<td>−</td>
<td></td>
<td>−</td>
<td></td>
</tr>
<tr>
<td>Psoriasis diagnosis</td>
<td>33.00 (19.00, 43.00)</td>
<td>−</td>
<td>30.00 (19.00, 46.00)</td>
<td>−</td>
<td></td>
<td>−</td>
<td></td>
</tr>
<tr>
<td>Disease duration at (years)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Recent axial radiograph</td>
<td>15.50 (7.00, 26.00)</td>
<td>19.00 (10.00, 29.00)</td>
<td>13.00 (6.00, 23.00)</td>
<td>−</td>
<td>0.13‡</td>
<td>−</td>
<td>0.41†</td>
</tr>
<tr>
<td>Clinical assessment</td>
<td>18.00 (9.00, 27.00)</td>
<td>22.00 (10.00, 31.00)</td>
<td>15.00 (7.00, 26.00)</td>
<td>−</td>
<td>0.13‡</td>
<td>−</td>
<td>0.34†</td>
</tr>
<tr>
<td>C reactive protein</td>
<td>3 (2, 7)</td>
<td>4 (1, 10)</td>
<td>2 (0, 5)</td>
<td>1.06 (0.99 to 1.12)</td>
<td>0.07‡</td>
<td>0.79 (0.74 to 0.84)</td>
<td>&lt;0.0001‡</td>
</tr>
<tr>
<td>Body mass index (BMI)</td>
<td>29.52 (5.16)</td>
<td>29.92 (4.96)</td>
<td>29.69 (5.36)</td>
<td>−1.60 (−2.21 to −0.84)</td>
<td>0.01*</td>
<td>−0.18 (−0.62 to 0.51)</td>
<td>0.81*</td>
</tr>
</tbody>
</table>

*Two-tailed Student’s t-test.
†Mann-Whitney U test.
‡Poisson regression (adjusted for: sex, age, disease duration, anti-TNF use ever, synthetic DMARD use ever, and BMI).
Anti-TNF, antitumour necrosis factor; AS, ankylosing spondylitis; DMARD, disease modifying antirheumatic drug; Mean diff, mean difference; pPsA, peripheral psoriatic arthritis; PsSpA, psoriatic spondyloarthropathy.

Table 3  Axial inflammatory symptoms, extra-articular manifestations and family history in PsSpA (n=127), AS (n=157) and pPsA (n=118) cases

<table>
<thead>
<tr>
<th>Inflammatory axial symptoms</th>
<th>PsSpA n (%)</th>
<th>AS n (%)</th>
<th>pPsA n (%)</th>
<th>OR adj 95% CI</th>
<th>p Value</th>
<th>OR adj 95% CI</th>
<th>p Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Spine or buttocks</td>
<td>65 (55)</td>
<td>133 (85)</td>
<td>54 (43)</td>
<td>2.76</td>
<td>1.62 to 4.71</td>
<td>&lt;0.001*</td>
<td>0.57</td>
</tr>
<tr>
<td>Ever (past/current)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Spine or buttocks</td>
<td>88 (75)</td>
<td>156 (99)</td>
<td>77 (61)</td>
<td>28.45</td>
<td>3.65 to 221.74</td>
<td>0.001*</td>
<td>0.69</td>
</tr>
<tr>
<td>Cervical</td>
<td>71 (60)</td>
<td>132 (84)</td>
<td>54 (43)</td>
<td>1.82</td>
<td>0.94 to 3.55</td>
<td>0.08*</td>
<td>0.73</td>
</tr>
<tr>
<td>Thoracic</td>
<td>50 (42)</td>
<td>114 (73)</td>
<td>27 (21)</td>
<td>2.20</td>
<td>1.23 to 3.92</td>
<td>0.01*</td>
<td>0.48</td>
</tr>
<tr>
<td>Lumbar</td>
<td>70 (59)</td>
<td>149 (95)</td>
<td>58 (46)</td>
<td>6.75</td>
<td>2.82 to 16.16</td>
<td>&lt;0.001*</td>
<td>0.82</td>
</tr>
<tr>
<td>Buttocks</td>
<td>55 (47)</td>
<td>132 (84)</td>
<td>24 (19)</td>
<td>3.19</td>
<td>1.67 to 6.07</td>
<td>&lt;0.001*</td>
<td>0.38</td>
</tr>
<tr>
<td>Extra-articular manifestations (ever)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dactylitis</td>
<td>37 (31)</td>
<td>8 (5)</td>
<td>50 (39)</td>
<td>0.18</td>
<td>0.07 to 0.42</td>
<td>&lt;0.001*</td>
<td>1.09</td>
</tr>
<tr>
<td>Enthesitis</td>
<td>56 (47)</td>
<td>58 (37)</td>
<td>59 (46)</td>
<td>0.70</td>
<td>0.43 to 1.14</td>
<td>0.15*</td>
<td>0.93</td>
</tr>
<tr>
<td>Chest wall pain</td>
<td>52 (44)</td>
<td>102 (65)</td>
<td>34 (27)</td>
<td>1.21</td>
<td>0.70 to 2.19</td>
<td>0.52*</td>
<td>0.63</td>
</tr>
<tr>
<td>Uveitis</td>
<td>31 (26)</td>
<td>84 (54)</td>
<td>11 (9)</td>
<td>1.44</td>
<td>0.79 to 2.62</td>
<td>0.24*</td>
<td>0.52</td>
</tr>
<tr>
<td>Inflammatory bowel disease</td>
<td>13 (11)</td>
<td>15 (10)</td>
<td>2 (2)</td>
<td>0.85</td>
<td>0.36 to 1.98</td>
<td>0.70*</td>
<td>0.12</td>
</tr>
</tbody>
</table>

*Multivariable reverse-stepwise logistic regression model (adjusted for potential covariates, including: sex, age at assessment, disease duration at assessment, HLA-B*27 status, synthetic DMARD use ever, anti-TNF use ever, smoking ever and body mass index).
†Reverse-stepwise logistic regression model adjusted for HLA-B*27 status.
Anti-TNF, antitumour necrosis factor; AS, ankylosing spondylitis; DMARD, disease modifying antirheumatic drug; n, proportion; OR adj, adjusted OR; pPsA, peripheral psoriatic arthritis; PsSpA, psoriatic spondyloarthropathy.

Axial radiographic comparison of PsSpA and AS cases

Excellent inter-rater (ICC ≥0.85) and intrarater (ICC ≥0.88) reliability was achieved by raters for the PASRI, mSASSS and regional subdomains.

Axial radiographic pattern

The predominant pattern of sacroiliitis in both AS (142/147; 96.60%) and PsSpA (65/79; 82.28%) cases was bilateral (table 4), albeit statistically different (p=0.001) (table 4). Symmetrical grade sacroiliitis was the predominant pattern in both PsSpA (60/79; 75.95%) and AS (119/147; 80.95%), with no difference between diseases (p=0.65). There was no significant difference between AS and PsSpA in terms of the occurrence of spondylitis (cervical and/or lumbar), cervical vertebral spondylitis, cervical facet joint fusion or lumbar vertebral spondylitis.

Of 118 cases classified as PsSpA: 45/118 (38.14%) had sacroiliitis with spondylitis, 39/118 (33.05%) had spondylitis alone and 34/118 (28.81%) had sacroiliitis alone. The majority of
PsSpA cases with spondylitis alone were symptomatic (22/39; 56.41%); although were less likely to be symptomatic than PsSpA cases with sacroiliitis with or without spondylitis (66/79; 83.54%) (OR 0.26; 95% CI 0.11 to 0.61, p=0.002). Thoracic spine radiographs, MRI and CT scans were available on 32/39 PsSpA cases with spondylitis alone, and none demonstrated diffuse idiopathic hyperostosis (DISH), defined as per the criteria of Resnick.40

Correlation of radiographic pattern with HLA-B*27 status in PsSpA cases

HLA-B*27 was present in 6/39 (15.38%) of PsSpA cases with spondylitis alone, 11/34 (32.35%) of cases with sacroiliitis alone and 30/45 (66.67%) of cases with both sacroiliitis and spondylitis. Logistic regression (adjusted for sex, age and disease duration) demonstrated a significantly increased probability for the presence of HLA-B*27 in PsSpA cases with both sacroiliitis and spondylitis, compared with spondylitis alone (ORadj 9.10; 95% CI 3.01 to 27.47, p<0.001).

Axial radiographic morphology

AS cases were more likely than PsSpA cases to have complete SIJ ankylosis (ORadj 2.96; 95% CI 1.42 to 6.15, p=0.004), vertebral bridging syndesmophytes (ORadj 2.78; 95% CI 1.49 to 5.18, p=0.001), but not partial SIJ ankylosis, SIJ erosion, SIJ sclerosis, vertebral non-bridging syndesmophytes or vertebral erosions (table 4).

Axial radiographic severity

Axial radiographic severity measured using the PASRI (and mSASSS) was lower in women compared with men in both PsSpA (median 5.5 vs 7.0; IRRadj 0.62 per unit increase; 95% CI 0.57 to 0.67, p<0.001) and AS cases (median 8 vs 18; IRRadj 0.67 per unit increase; 95% CI 0.61 to 0.73, p<0.001).

Axial radiographic severity was higher in AS than PsSpA, as measured by the PSRI (median 15 vs 6; IRRadj 1.13 per unit increase; 95% CI 1.09 to 1.19, p<0.001) and the mSASSS (median 10 vs 3; IRRadj 1.09 per unit increase; 95% CI 1.04 to 1.14, p<0.001). Severity in AS was also greater than PsSpA when analysed by axial region: cervical vertebral PASRI (IRRadj 1.57 per unit increase; 95% CI 1.35 to 1.83, p<0.001), cervical facet joint PASRI (IRRadj 1.47 per unit increase; 95% CI 1.08 to 1.99, p=0.01) and lumbar vertebral PASRI (IRRadj 1.42 per unit increase; 95% CI 1.29 to 1.58, p<0.001).

Using the mSASSS in PsSpA, the cervical region was more severely affected than the lumbar spine (IRRadj 1.54 per unit increase; 95% CI 1.20 to 1.74, p<0.001), but similar in AS. Vertebral osteoproliferative severity, as measured by the PASRI, (bridging and/or non-bridging syndesmophytes) was higher in AS than PsSpA (median 6 vs 2; IRRadj 1.31 per unit increase; 95% CI 1.09 to 1.57, p=0.004). Vertebral erosion severity was no different in the two diseases.

DISCUSSION

Studies suggest a high degree of overlap between pPsA, PsSpA and AS; but are few in number and frequently of small sample size. We therefore sought to further define the similarities and differences between these conditions, and whether these could be explained by clinical and genetic parameters. Axial disease was defined radiographically, due to the robustness and reproducibility of doing so. Accordingly, a significant proportion of PsA cases were reclassified to the PsSpA phenotype, and found to often be asymptomatic. Importantly, a quarter of PsA and AS

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### Table 4 Axial radiographic pattern and morphology in PsSpA (n=118) and AS (n=157) cases

<table>
<thead>
<tr>
<th>Pattern</th>
<th>PsSpA n (%)</th>
<th>AS n (%)</th>
<th>AS versus PsSpA OR 95% CI p Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sacroiliitis</td>
<td>79 (67)</td>
<td>157 (100)</td>
<td>–</td>
</tr>
<tr>
<td>Spondylitis (cervical and/or lumbar)</td>
<td>84 (71)</td>
<td>109 (69)</td>
<td>0.94</td>
</tr>
<tr>
<td>Sacroiliitis pattern</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bilateral</td>
<td>65/79 (82)</td>
<td>142/147 (97)</td>
<td>6.14</td>
</tr>
<tr>
<td>Symmetrical grade</td>
<td>60/79 (76)</td>
<td>119/147 (81)</td>
<td>1.17</td>
</tr>
<tr>
<td>Spondylitis pattern</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cervical vertebrae</td>
<td>52/116 (45)</td>
<td>85 (54)</td>
<td>1.20</td>
</tr>
<tr>
<td>Cervical facet joint</td>
<td>29 (25)</td>
<td>60 (38)</td>
<td>1.48</td>
</tr>
<tr>
<td>Lumbar vertebrae</td>
<td>50/117 (43)</td>
<td>85 (54)</td>
<td>1.37</td>
</tr>
<tr>
<td>Morphology</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sacroiliac joint</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sclerosis bilaterally (grade 2)</td>
<td>6 (5)</td>
<td>9 (6)</td>
<td>1.75</td>
</tr>
<tr>
<td>Erosion (grade 3)</td>
<td>42 (36)</td>
<td>53 (34)</td>
<td>1.07</td>
</tr>
<tr>
<td>Partial ankylosis (grade 3)</td>
<td>25 (21)</td>
<td>46 (29)</td>
<td>1.08</td>
</tr>
<tr>
<td>Complete ankylosis (grade 4)</td>
<td>18 (15)</td>
<td>68 (43)</td>
<td>2.96</td>
</tr>
<tr>
<td>Vertebral</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Erosion, n (%)</td>
<td>3 (3)</td>
<td>6 (4)</td>
<td>1.58</td>
</tr>
<tr>
<td>Non-bridging syndesmophyte</td>
<td>47 (40)</td>
<td>58 (37)</td>
<td>0.93</td>
</tr>
<tr>
<td>Bridging syndesmophyte</td>
<td>12 (10)</td>
<td>36 (23)</td>
<td>2.78</td>
</tr>
</tbody>
</table>

*Multivariate reverse-stepwise logistic regression model (adjusted as required for the following potential covariates: sex, age at radiographic assessment, disease duration at radiographic assessment, HLA-B*27 status, anti-TNF use ever, synthetic DMARD use ever, smoking and BMI). Anti-TNF, antitumour necrosis factor; AS, ankylosing spondylitis; BMI, body mass index; DMARD, disease modifying antirheumatic drug; PsSpA, psoriatic spondyloarthritis.

cases were classifiable as the other disease using the currently available classification systems.

In PsSpA cases, spondylitis without sacroilitis was common and usually symptomatic. Our methods ensured we were not scoring degenerative lesions as being inflammatory, and the thoracic imaging of these cases confirmed that they did not simply have DISH. Previous studies have shown similarly high prevalence of spondylitis without sacroilitis,3 4 and proposed it as a feature distinguishing PsSpA from AS.4 5 The differing prevalence of HLA-B*27 alleles in our radiographic subphenotypes of PsSpA offers a unique insight, and implies aetiopathogenic differences between sacroilitis and spondylitis in PsSpA.

AS cases were more likely than PsSpA cases to have complete SIJ ankylosis and bridging syndesmophytes. These features may prove more useful than syndesmophyte shape67 to distinguish PsSpA from AS. Unilateral or asymmetrical grade sacroilitis, reported to be characteristic of PsSpA,6 were not found in the current study, possibly as we have a more established disease cohort at a later stage of radiographic disease. We do plan to explore the association between certain HLA-B alleles and their haplotypes, with symmetry of sacroilitis, as has recently been described by Haroon et al.48

Previous studies have found clinical predictors for PsSpA occurrence in PsA include: male sex,4 9 the presence of HLA-B*27,10 nail dystrophy,13 higher number of radiographically damaged joints,15 high erythrocyte sedimentation rate,15 and longer disease duration, with axial disease being a late-onset feature.8 12 The latter clinical predictor may explain much of the variation in estimated prevalence of PsSpA in PsA cohorts, as many studies have investigated PsA cases with relatively recent onset disease, allowing insufficient time for the PsSpA phenotype to have fully expressed. We acknowledge that to truly understand the natural history of axial disease in PsA, a longitudinal inception cohort study is required. Predictors of PsSpA occurrence in our PsA cohort included: the presence of HLA-B*27, younger age at arthritis onset, higher nail onycholysis severity, axial inflammatory symptoms and IBD. Onycholysis may be a more specific marker of synovial-entheseal complex inflammation, a process considered important in SpA pathogenesis,49 and giving further biological credence to our finding. The presence of psoriatic nail disease has been shown in another study to be a biomarker of higher systemic enthesopathy burden and higher inflammatory scores, measured using ultrasound.50

PsSpA is not a clinically less impactful form of AS; measures of disease activity (ASDAS, BASDAI and PaGA), disability (HAQ) and metrology (BASMI) were high in both PsSpA and AS cases, with no statistically significant difference between groups. Of note, 74% of PsSpA cases had peripheral arthritis, and erosions were observed in 64% (48/75) of those with available radiographs, hence the additional burden of peripheral joint disease may have influenced at least some of these measures.

The reliability of our results is improved by a large sample size, single-centre follow-up, excellent inter-rater reliability for radiographic scoring, no missing clinical data, limited (<3%) missing radiographic data and a single rheumatologist performing clinical assessments; the inter-rater reliability of clinical assessments in PsA is known to be poor.51 A limitation of our study was the lack of MRI, inclusion of which on all patients would have made the study unfeasible, and introduced selection bias if only analysed for some of the cohort. Quantitative radiographic scoring with embedded morphological data improved the study’s power to detect differences between groups. Inclusion of comprehensive covariate data in multivariable models allowed adjustment for potential confounders, in particular disease duration. Our findings are generalisable because the study was conducted in a secondary care hospital taking unselected PsA and AS referrals.

The impact of recall bias is likely curtailed by a similar magnitude and direction of effect in each SpA group. Unfortunately the cross-sectional study design reduced the ability to entirely adjust for: time-varying variables such as smoking, BMI and medication use; and unmeasured confounders such as NSAIID use, delayed diagnosis and physiotherapy. While anti-TNF therapy may inhibit43 54 or have no effect53 56 on syndesmophyte formation in AS, no data exist in PsSpA.

To conclude, this study indicates that PsSpA forms part of the SpA spectrum, flanked by pPsA and AS. In terms of most clinical indices of disease activity, PsSpA has a similar disease burden as AS, despite being less severe radiographically. This may be of relevance in the development of future treatment guidelines. Furthermore, PsSpA may represent a distinct endophenotype influenced by factors related to the presence of psoriasis, psoriatic nail disease and HLA-B*27 variants. In future work we plan to use our data set to further explore whether genetic variants are closely linked with more homogeneously defined patterns of disease.

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Axial Disease in Psoriatic Arthritis study: defining the clinical and radiographic phenotype of psoriatic spondyloarthritis

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