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## Associations of Lumbar Scoliosis with Presentation of Suspected Early Axial Spondyloarthritis

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1 *Original article*

2

3 **Running head:** Scoliosis and Presentation of Early Axial Spondyloarthritis

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5 **Associations of Lumbar Scoliosis with Presentation of Suspected Early Axial**  
6 **Spondyloarthritis**

7

8 Marie Voirin-Hertz (MD)<sup>1\*</sup>, Guillermo Carvajal Alegria (MD)<sup>1\*</sup>, Florent Garrigues (MD)<sup>2</sup>,  
9 Alexandre Simon (MD)<sup>3</sup>, Antoine Feydy (MD, PhD)<sup>4</sup>, Monique Reijnierse (MD)<sup>5</sup>, Désirée  
10 van der Heijde (MD, PhD)<sup>6</sup>, Damien Loeuille (MD, PhD)<sup>7</sup>, Pascal Claudepierre (MD, PhD)<sup>8</sup>,  
11 Thierry Marhadour (MD)<sup>1</sup>, and Alain Saraux (MD, PhD)<sup>1,9</sup>

12

13 <sup>1</sup>Rheumatology Unit, Hôpital de la Cavale Blanche, Brest 29609, France

14 <sup>2</sup>Radiology Unit, Hôpital de la Cavale Blanche, Brest 29609, France

15 <sup>3</sup>Neurosurgery Unit, Hôpital de la Cavale Blanche, Brest 29609, France

16 <sup>4</sup>Radiology B Department, Paris Descartes University, Cochin Hospital, Paris France

17 <sup>5</sup>Department of Radiology, Leiden University Medical Center, Leiden, the Netherlands

18 <sup>6</sup>Department of Rheumatology, Leiden University Medical Center, Leiden, the Netherlands

19 <sup>7</sup>Department of Rheumatology, Nancy, France

20 <sup>8</sup>AP-HP, Groupe Hospitalier Henri-Mondor, Service de Rhumatologie, Créteil, 94000,  
21 France; Université Paris Est Créteil, EA 7379 – EpidermE, Créteil, 94000, France;

22 <sup>9</sup>INSERM 1227, Université de Bretagne Occidentale, LabEx IGO, Brest, France

23 \*These two authors contributed equally to the work and should be considered co-first  
24 authors.

25

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3 **Corresponding author:**

4 Prof. Alain Saraux

5 Rheumatology Unit, Hôpital de la Cavale Blanche, BP 824, F 29609 Brest cedex, France

6 Tel: +33 298 347 268; Fax: +33 298 493 627

7 E-mail: alain.saraux@chu-brest.fr

8

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1 **ABSTRACT (235 words)**

2 **Objective:** Scoliosis may impact the mechanical loading and cause secondary changes of the  
3 sacroiliac joints and lumbar spine. Our goal was to look how lumbar scoliosis modify the  
4 clinical and imaging-study in patients with recent-onset inflammatory back pain (IBP)  
5 suggesting axial spondyloarthritis (axSpA).

6 **Methods:** Baseline weight-bearing lumbar-spine radiographs obtained in the DESIR cohort  
7 of patients aged 18-50 years and having IBP for at least 3 months but less than 3 years  
8 suggesting axSpA were studied. After training on scoliosis detection based on Cobb's  
9 angle  $>10^\circ$  plus Nash-Moe grade  $\geq 1$ , readers blinded to patient data measured spine lumbar  
10 scoliosis, sacral horizontal angle, lumbosacral angle and total lordotic angle on the  
11 radiograph of the lumbar and scored sacroiliitis on the radiograph of the pelvis. Baseline  
12 MRIs T1 and STIR of the lumbar spine and sacroiliac joints were evaluated for respectively  
13 degenerative changes and signs of axSpA.

14 **Results:** Of the 360 patients (50.8% females) 88.7% had lumbar pain and 69.3% met ASAS  
15 criteria for axSpA. Mean Cobb's angle was  $3.2^\circ \pm 5.0^\circ$  and 28 (7.7%) patients had lumbar  
16 scoliosis. No statistical differences were observed for radiographic sacroiliitis, MRI  
17 sacroiliitis, modified Stoke Ankylosing Spondylitis Spinal Score, Pfirrmann score, high-  
18 intensity zone, protrusion, extrusion, MODIC score between patients with and without  
19 scoliosis. In both groups, degenerative changes by MRI were rare and predominated at L4-  
20 L5 and L5-S1.

21 **Conclusion:** In patients with early IBP suggesting axSpA, lumbar scoliosis was not  
22 associated with inflammatory or degenerative changes.

23

24 **Key words:** Ankylosing spondylitis. Axial spondyloarthritis. Lumbar scoliosis. Lumbar  
25 lordosis. Sacral slope. Degenerative disease.

## 1 **Significance and Innovations**

- 2 - A normal to low prevalence of 7.7 % lumbar scoliosis and lordosis is found in  
3 patients between 18-50 years who had early IBP in the DESIR cohort. (7.7 % of  
4 patients with early IBP suggesting axSpA have lumbar scoliosis)
- 5 - Lumbar scoliosis is not associated with changes in clinical or imaging-study findings  
6 in this context.
- 7 - lumbar scoliosis is not associated with secondary changes to mechanical loading as  
8 sclerosis or BME of the sacroiliac joints.
- 9 - Lumbar scoliosis has no impact on the MR diagnosis of sacroiliitis on radiographs  
10 and MR SI joints.

11

## 1 INTRODUCTION

2  
3 Back pain has a lifetime prevalence of 70% in the general population (1,2). In most  
4 patients, back pain is a nonspecific symptom that is related to mechanical factors whose  
5 exact cause is identified in fewer than half the cases (3).

6 Scoliosis (4) is a three-dimensional spinal deformity that can cause back pain. The  
7 main diagnosis criterion is a coronal curvature with a Cobb's angle greater than 10° on the  
8 anteroposterior radiograph. In addition, the assessment of pedicle position according to the  
9 Nash-Moe technique shows vertebral rotation (Nash-Moe grade >1) (1,5,6). The prevalence  
10 of scoliosis has been estimated at 1%-3%. Idiopathic scoliosis accounts for about 80% of all  
11 structural coronal deformities, with a prevalence of 1%-2% among schoolchildren up to age  
12 15. In adults, the prevalence of idiopathic scoliosis has been reported to increase with age  
13 from 8% starting at 25 years to 68% between 60 and 80 years, due in part to the development  
14 of degenerative spinal lesions (1) (2,8-14). Scoliosis causes multifactorial low back pain,  
15 whose typically mechanical pattern may be combined with an inflammatory component, for  
16 instance in the event of vertebral endplate edema (3,7). The pain may be chronic or  
17 recurrent. Scoliosis also restricts spinal mobility.

18 Degenerative disease of the spine on radiographs has a high prevalence in the general  
19 population with back pain (121 to 274, 44%) and clinical correlation with MR imaging  
20 findings is low (15). These include dehydration of discs and loss of disc height, a high-  
21 intensity zone (HIZ) in the posterior annulus of the disk, disk herniation, Modic type  
22 vertebral endplate changes, facet-joint osteoarthritis, interspinous bursitis (rare and not  
23 scored by us), degenerative spondylolisthesis (3). The presence of scoliosis accelerates the  
24 development of degenerative changes of the spine. In addition the change the mechanical  
25 loading may cause secondary changes in the SI joints as reactive sclerosis or bone marrow  
26 edema.

1           In axial spondyloarthritis (axSpA), back pain is a key manifestation. Thus,  
2 inflammatory back pain (IBP) in younger patients predominantly suggests axSpA. The early  
3 diagnosis of axSpA is challenging and relies on a convergence of evidence from the medical  
4 history, physical examination, laboratory tests, and imaging studies (16–19). Degenerative  
5 changes are common in the general population and in axSpA. Thus, in the SPACE cohort,  
6 90% of patients classified as having possible or definite axSpA also had degenerative  
7 changes by MRI, which predominated at the lumbar spine (15). However, the prevalence of  
8 lumbar scoliosis in patients with axSpA has not been reported. Furthermore, no data exist on  
9 whether scoliosis is associated with differences in the clinical and/or imaging-study  
10 presentation of axSpA.

11           Our objective here was to evaluate whether lumbar scoliosis was associated with  
12 differences in clinical manifestations, imaging-study findings, and/or the degree of axSpA  
13 diagnosis certainty in the DESIR cohort of patients with recent-onset IBP and suspected  
14 axSpA.

## 1 PATIENTS AND METHODS

2

### 3 **The DESIR cohort**

4 DESIR (DEvenir des Spondyloarthropathies Indifférenciées Récentes) is a French  
5 prospective, multicenter, cohort established between October 2007 and April 2010. Adults  
6 aged 18 to 50 years were included if they had inflammatory pain in the thoracic spine,  
7 lumbar spine, and/or buttock(s) meeting Calin and/or Berlin criteria (16), of more than 3  
8 months' but less than 3 years' duration, leading to a determination by the local investigator  
9 that the probability of axSpA was at least 5 on a 0-10 numerical rating scale (0, not  
10 suggestive at all; 10, highly suggestive). The baseline characteristics of the patients are  
11 described in detail elsewhere (20,21).

12 The DESIR cohort study complied with good clinical practice guidelines, was  
13 registered on Clinical Trials.gov (NCT0164 8907), and was approved by the appropriate  
14 ethics committee (CPP Ile-de-France III, submission number P070302). Before study  
15 inclusion, each patient gave written informed consent and permission to publish any  
16 individual anonymized data. A detailed description of the study protocol is available online  
17 at <http://www.lacohortedesir.fr/desir-in-english/>. The research project was approved by the  
18 DESIR scientific committee. For this study, the database was locked in 2014. Standing,  
19 weight-bearing, antero-posterior radiographs of the lumbar spine were used.

### 20 **Assessment of imaging studies**

21 *Evaluation of scoliosis.* We used Cobb's angle (1,5,6) to quantify spinal curvature in the  
22 frontal plane and the Nash-Moe grade to assess vertebral rotation. Cobb's angle is subtended  
23 by the line along the superior endplate of the vertebra at the top of the curve and a line along  
24 the inferior endplate of the vertebra at the bottom of the curve. The Nash-Moe grade based  
25 on pedicle shadow position reflects the degree of rotation of the vertebra at the apex of the



1 curve; the grade can range from 0 (no rotation) to 4 (major rotation) (5,6). Two rheumatology  
2 fellows (MVH and GCA) received training from a spine specialist then evaluated the  
3 baseline anteroposterior lumbar-spine radiograph (in DICOM format) of each patient for  
4 evidence of scoliosis (**Figure 1**), on two separate occasions separated by at least 2 days.  
5 Patients with a Cobb's angle  $\geq 10^\circ$  and a Nash-Moe grade  $\geq 1$  were classified as having  
6 scoliosis and other patients as being free of scoliosis (1,5,6). Disagreements between the two  
7 readers (scoliosis yes/no) were resolved by having the spine specialist (TM) repeat the  
8 measurements.

9 *Evaluation of degenerative disease.* As part of the DESIR cohort data collection process, the  
10 baseline lumbar-spine radiograph and MRI scan of each patient had been previously assessed  
11 for degenerative changes by two readers blinded to all patient data (15). Radiographic  
12 degenerative changes were recorded as present/absent at L3-L4, L4-L5, and L5-S1, as they  
13 are the most affected by degenerative changes. The MRI scans were also assessed for disk  
14 degeneration, Modic changes, Pfirrmann grade, canal stenosis, disk herniation/extrusion,  
15 HIZ, facet-joint osteoarthritis, spondylolisthesis, and Schmorl's nodes at L3-L4, L4-L5, and  
16 L5-S1. For this study, Pfirrmann grades I and II were considered normal and grades III, IV,  
17 or V as indicating degenerative disease; disagreements between the two readers were  
18 resolved by a third reader.

19 *Angle measurements.* For another DESIR cohort study, two readers used the baseline lateral  
20 lumbar-spine radiographs to measure sacral slope (SS) as the angle formed by the line along  
21 the upper endplate of S1 and the horizontal plane (22) and total lordotic angle (TLA) formed  
22 by the lines drawn along the upper endplates of L1 and S1(22–24). Lumbosacral angle  
23 (LSA) formed by two lines drawn along the lower L5 endplate and upper S1 endplate,  
24 respectively; sacral horizontal angle (SHA) between the horizontal line and the line along the

1 upper S1 endplate; and the total lordotic angle (TLA) between the lines along the upper L1  
2 and S1 endplates. The values were used for the present study.

3 *Imaging abnormalities suggesting axSpA.* We also compared the right or left curved  
4 scoliosis to the right and left sacroiliac joints joint for grade of sclerosis on radiograph and  
5 bone marrow edema on sacroiliac MRI. As part of the DESIR cohort data collection process,  
6 baseline radiographs of the spine and pelvis were used to assess New-York modified criteria  
7 for sacroiliitis (25), the modified Stoke Ankylosing Spondylitis Spinal Score (mSASSS  
8 score) (26), and the Bath Ankylosing Spondylitis Radiology Index (BASRI) (27); baseline  
9 MRI scans were evaluated for evidence of sacroiliitis (28) and determination of the  
10 sacroiliac and spinal SPondyloARthritis Research Consortium of Canada MRI inflammation  
11 (SPARCC) score (29–30). Ranges of the scoring systems are included in the tables showing  
12 the results.

### 13 **Statistical analysis**

14 Intraobserver repeatability and interobserver reproducibility of the diagnosis of  
15 scoliosis were estimated by computing the kappa coefficients, which were interpreted  
16 according to Landis and Koch (0.61-0.80, substantial agreement; and 0.81-1, near perfect  
17 agreement). Patients with and without scoliosis were compared regarding the clinical  
18 presentation (demographics, pain pattern, spinal mobility, and other features), the prevalence  
19 of degenerative disease (presence or absence) visible radiographically and by MRI, and the  
20 degree of confidence in a diagnosis of axSpA. All data were evaluated at baseline.  
21 Associations between these variables and scoliosis were sought by univariate analysis using  
22 the chi-square test (or Fisher's exact test when appropriate) or the Mann-Whitney test. We  
23 also verified that Cobb' angle was not correlated to either mSASSS or grade of sacroiliitis on  
24 X-rays using the Spearman's coefficient.

1           With Bonferroni's correction, *P* values <0.001 were required to indicate significant  
2 differences. Statistical analyses were performed using SPSS 23.0 software (IBM, Armonk,  
3 NY).

## 1 RESULTS

2

### 3 Study group

4 From the DESIR cohort, 362 patients with available standing, weight-bearing,  
5 anteroposterior lumbar-spine radiographs were included in the study. Mean Cobb's angle  
6 was  $3.2^{\circ} \pm 5.0$ , with a maximum of  $32^{\circ}$ . Of the 362 patients, 28 (7.7%) had scoliosis. The  
7 Nash-Moe grade was I or II in all patients. No patient had severe scoliosis. In the overall  
8 patient population, the intraobserver kappa coefficient was 1, indicating perfect agreement,  
9 and the interobserver kappa coefficient was 0.7, indicating substantial agreement.

10 The baseline characteristics of the 362 patients were similar to those of the entire  
11 cohort (supplementary table 1): mean age was  $33.2 \pm 8.4$  and 50.8% of patients were female;  
12 88.7% of patients had low back pain and 72.7% had buttock pain. The ASAS classification  
13 criteria for axSpA were met by 69.3% of patients at baseline (**Table 1**). No patient had  
14 spondylolysis and very few patients had spondylolisthesis, Modic changes, canal stenosis, or  
15 facet-joint osteoarthritis.

16

### 17 Associations of scoliosis with clinical presentation and confidence in a diagnosis of 18 axSpA

19 **Table 2** compared the clinical characteristics in the groups with and without scoliosis.  
20 No statistically significant differences were found for demographic data, site or features of  
21 the pain, or motion range of the lumbar spine. Neither range of motion of the lumbar spine  
22 nor the degree of confidence in a diagnosis of axSpA differed between the two groups.

23

### 24 Associations of scoliosis with imaging-study abnormalities

1           **Table 3** reports the results of tests for associations linking scoliosis to SS and TLA  
2 values measured on radiographs and to MRI signs of degenerative disease. Overall, MRI  
3 abnormalities were extremely uncommon, with no significant between-group differences; for  
4 each abnormality, the numbers were too small for statistical analyses. Except for Schmorl's  
5 nodes, the MRI abnormalities predominated at L4-L5 and L5-S1.

6           TLA was non-significantly greater in the group with scoliosis (58.9° vs. 52.4°,  
7  $P=0.009$ ). SS was non-significantly greater in the group with scoliosis (42.2° vs. 39.0,  
8  $P=0.03$ ).

9           Scoliosis was not associated with abnormalities suggesting axSpA by radiography  
10 (New York criteria, mSASSS score, BASRI score and SPARCC score) or MRI (ASAS  
11 criteria and SPARCC score) (**Table 4**). The Cobb'angle was not correlated to either  
12 mSASSS ( $r -0.28$ ,  $p0.61$ ) or grade of sacroiliitis on X-rays (left:  $r=0.60$ ,  $p0.26$ ; right:  $r=0.01$ ,  
13  $p0.78$ ).

14  
15

## 16 **DISCUSSION**

17

18           In this study, lumbar scoliosis was not significantly associated with the clinical or  
19 imaging-study features of patients with early IBP. Thus, patients with and without scoliosis  
20 did not differ regarding nocturnal pain, morning stiffness according to the Berlin criteria,  
21 chronicity of the symptoms, and confidence in a diagnosis of axSpA. Moreover, the  
22 proportion of patients meeting ASAS criteria was the same in the two groups, indicating that  
23 lumbar scoliosis did not increase the risk of mistakenly diagnosing axSpA in this population

1 of patients in whom the local investigators rated the likelihood of axSpA at 5 or more on a  
2 10-point scale (32).

3 Lumbar scoliosis might be expected to diminish the range of forward bending. In a  
4 study of adolescent idiopathic scoliosis, forward bending was restricted in proportion to the  
5 amount of curvature and rotation (10). Furthermore, an association has been reported  
6 between scoliosis and spinal degenerative disease. However, the modified Schober's test  
7 and finger-floor distance were similar in our groups with and without scoliosis. This finding  
8 may be ascribable to the characteristics of our patients, who were young, with little evidence  
9 of degenerative disease, and whose lumbar scoliosis was usually mild (23).

10 Sagittal lumbosacral balance as assessed on radiographs did not differ between the  
11 groups with and without scoliosis. In patients with scoliosis, total lordosis and SS were non-  
12 significantly greater than in patients without scoliosis. In both groups, the TLA and SS  
13 values were within the normal ranges. Few studies have addressed sagittal lumbosacral  
14 balance in patients with scoliosis (31,32). In 160 patients with adolescent idiopathic scoliosis  
15 (34), lumbar lordosis was non-significantly greater in the group with lumbar curves. Some  
16 studies suggest that greater lordosis may not be associated with the progression of scoliosis  
17 (33,34).

18 Data on potential associations of lumbar lordosis with degenerative changes and low  
19 back pain are conflicting. In a study of 112 females aged 40-72 years, the angle of lordosis  
20 was not significantly different in the groups with and without radiographic degenerative  
21 disease of the lumbar spine (23). The TLA may be associated with spondylolysis and  
22 spondylolisthesis but not with other manifestations of spinal degenerative disease (24).

23 MRI abnormalities were rare in both groups, suggesting that lumbar scoliosis may not  
24 be associated with an increased risk of spinal degenerative disease in adults with early IBP  
25 who are younger than 50 years of age. Nevertheless, scoliosis was associated with

1 degenerative disease in many studies, with some parameters correlating with low back pain.  
2 Thus, Modic changes were more common or more marked in patients with scoliosis (13,14)  
3 and predominated at the curve apex concavity (9,11). Severe facet-joint degeneration was  
4 associated with painful lumbar scoliosis (2,8,10,11). One study found that Schmorl's nodes  
5 were associated with pain in pediatric patients with scoliosis who had Schmorl's nodes (9).  
6 Other degenerative lesions such as foraminal stenosis and spondylolisthesis may correlate  
7 with symptoms in patients with lumbar scoliosis (11). In our study, degenerative changes at  
8 the lumbar spine were found in similar proportions of patients with and without lumbar  
9 scoliosis. This finding may be ascribable to the relatively young age of the patients and to  
10 the mild nature of most of the cases of lumbar scoliosis. Alternatively, any deleterious  
11 effects of lumbar scoliosis may have been counterbalanced by an increase in lumbar lordosis.  
12 In a study of patients who had two MRI scans of the lumbar spine at a 4-year interval,  
13 lordosis was more marked in patients with no degenerative disease progression (14).  
14 Scoliosis was not associated with progression. In the SPACE cohort of patients aged 16 to  
15 45 years and presenting with chronic back pain, the prevalence of degenerative changes was  
16 89% by MRI and 44% by radiography, with no difference across the groups with and  
17 without axSpA; the prevalence of each type of degenerative change was far lower, although  
18 HIZ were seen at the lumbar spine in 62.4% of patients (19). The main strength of this study  
19 is the collection of a vast array of data in a large population. In addition, most of the imaging  
20 study assessments were done by experienced radiologists. Among the weaknesses is the  
21 focus on lumbar scoliosis. We did not obtain standing AP radiograph of the full-spine to  
22 quantify spinal curvature in a uniform and comparable method, as recommended by the  
23 American Scoliosis Research Society. Patients with low back pain may also have thoracic  
24 spinal pain with or without thoracic or thoracolumbar scoliosis. Thoracolumbar scoliosis can  
25 be missed and no information is available on S-shaped curve of the spine. Furthermore,

1 Cobb's angle, although the current reference standard for assessing scoliosis, measures a 2D  
2 curve, whereas scoliosis is a 3D deformity (5). However, we also assessed the Nash-Moe  
3 grade to evaluate vertebral rotation. Nevertheless, measurement error have been found to  
4 result in 2° to 7° differences in Cobb's angle values and the Nash-Moe grade can be properly  
5 assessed only on a true frontal view. The number of patients with scoliosis is low and the  
6 difference of number between the group with and without scoliosis might have decreased the  
7 statistical power of the study. Nevertheless, Cobb'angle was not correlated to either  
8 mSASSS or grade of sacroiliitis on X-rays.

9 In conclusion, in a large prospective cohort of patients with early IBP, lumbar scoliosis  
10 is infrequently seen and not associated with secondary changes to mechanical loading,  
11 sclerosis or bone marrow edema of the sacroiliac joints. Therefore there is no impact on the  
12 classification criteria for axSpA. Furthermore, lumbar spine degenerative changes were not  
13 more common in the patients with versus without lumbar scoliosis. These results were  
14 obtained in patients aged 18-50 years who had early IBP. It would be of interest to assess  
15 longitudinal data with AP full spine radiographs from the DESIR cohort with the aim of  
16 determining whether lumbar scoliosis is associated with the outcomes of axSpA.

17



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20

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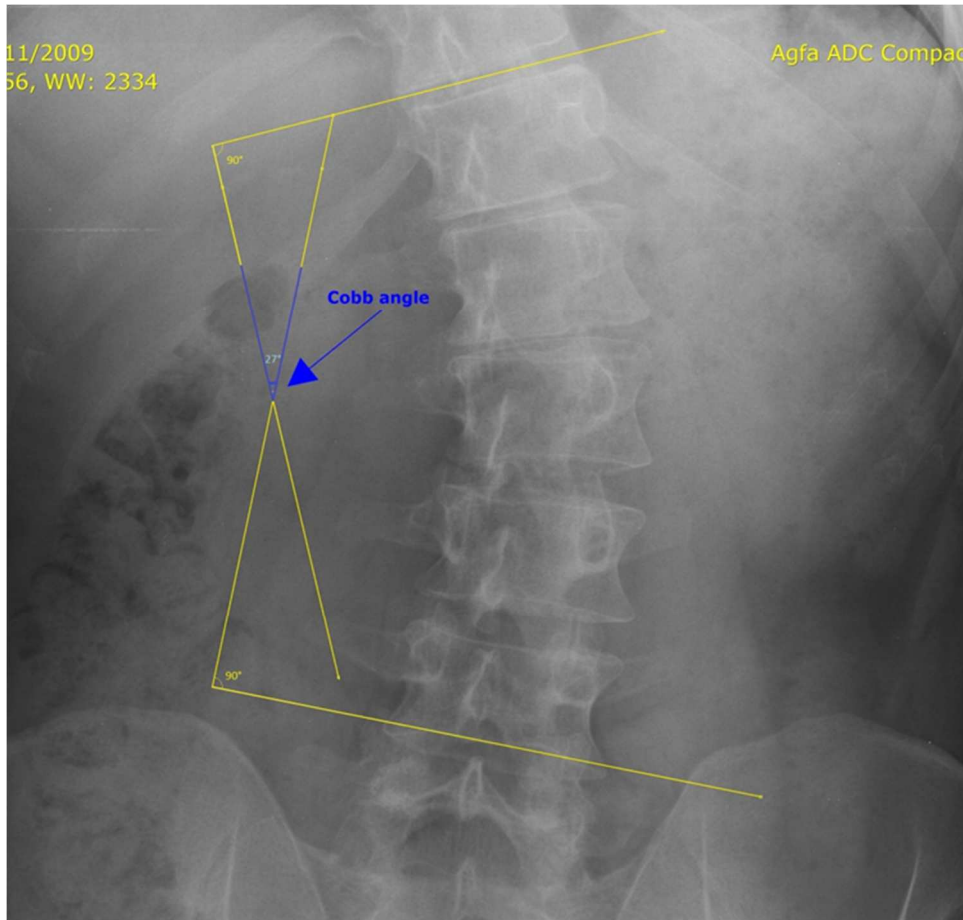
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1 **Figure 1.** Cobb's angle measurement on an anteroposterior radiograph of the lumbar spine



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3

1 **Table 1. Main patient characteristics at baseline (n=362)**

Age (years), mean±SD	33.2 ± 8.4
Males, n (%)	178 (49.2%)
BMI (m/kg <sup>2</sup> ), mean±SD	24.1±4.3
Low-back pain, <sup>a</sup> n (%)	321 (88.7%)
Buttock pain, <sup>a</sup> n (%)	263 (72.7%)
Morning stiffness (Berlin criteria), n/N (%)	329 (90.9%)
Nocturnal pain (Berlin criteria), n/N (%)	319 (88.1%)
Modified Schober test (10+Xcm), mean±SD	3.7 ± 1.1
Finger-floor distance (cm), mean±SD	13.0 ± 12.9
HLA B27 positivity, n (%) (n=674)	224 (61.9%)
ASAS criteria, n (%) (n:669)	251 (69.3%)
Confidence in a diagnosis of SpA at baseline, <sup>b</sup> mean±SD	7.4 ± 2.1
Sacral slope, °, mean±SD	39.3 ± 9.2
Lumbosacral angle, °, mean±SD	14.6 ± 4.6
TLA, °, mean±SD	53.0 ± 13.1
Lumbar scoliosis, n (%)	28 (7.7%)

2 <sup>a</sup> inclusion criterion

3 <sup>b</sup> assessed on a 1-10 scale by the investigator at each study center

4 BMI, body mass index; HLA, human leukocyte antigen; ASAS, Assessment of  
 5 SpondyloArthritis international Society; SpA, spondyloarthritis; TLA, total lordotic angle

6

1 **Table 2.** Associations of scoliosis with the clinical presentation and confidence in a  
 2 diagnosis of axSpA at baseline; ASAS criteria and confidence in a diagnosis of  
 3 spondyloarthritis are also reported after 2 years

<b>Characteristics</b>	<b>No scoliosis N=327</b>	<b>Scoliosis N=28</b>	<b>P value*</b>
Age (years), mean±SD	33.2 ± 8.4	31.9 ± 7.5	0.49
Males, n (%) (N=327)	163 (49.8)	12 (42.9)	0.48
Weight (kg), mean±SD	70.3 ± 13.4	67.0 ± 15.6	0.23
Height (cm), mean±SD	170.2 ± 9.3	168.6 ± 10.3	0.46
BMI (m/kg <sup>2</sup> ), mean±SD	24.1 ± 4.3	24.3 ± 3.4	0.41
Low back pain, n (%) (N=327)	289 (88.4)	26 (92.9)	0.47
Buttock pain, n (%) (N=327)	241 (73.7)	18 (62.3)	0.28
Morning stiffness (Berlin criteria), n (%) (N=327)	301 (92.0)	22 (78.6)	0.02
Nocturnal pain (Berlin criteria), n (%)	287 (87.8)	26 (92.9)	0.42
Modified Schober test (10+Xcm), mean±SD	3.7 ± 1.1	3.5 ± 1.0	0.18
Finger-floor distance (cm), mean±SD	12.9 ± 12.8	15.6 ± 14.2	0.23
HLA B27 positivity, n (%)	202 (61.8)	19 (67.8)	0.52
ASAS criteria met at baseline, n (%)	226/325 (69.5)	22 (78.6)	0.32
Confidence in a diagnosis of SpA at baseline, mean±SD <sup>a</sup>	7.3 ± 2.1	8.0 ± 2.1	0.06

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6 <sup>a</sup>inclusion criterion

7 <sup>b</sup>assessed on a 1-10 scale by the investigator at each study center

8 BMI, body mass index; HLA, human leukocyte antigen; ASAS, Assessment of

9 SpondyloArthritis international Society; SpA, spondyloarthritis

10



1 **Table 3.** Associations of scoliosis with radiographic sagittal balance and MRI signs of  
 2 degenerative disease at baseline

<b>Characteristics at baseline</b>	<b>No scoliosis (n= 306)</b>	<b>Scoliosis (n= 27)</b>	<b>P value*</b>
Pfirschmann L3-L4 $\geq 3$ , n (%)	14 (4.6)	2 (7.4)	0.51
Pfirschmann L4-L5 $\geq 3$ , n (%)	46 (15.0)	2 (7.4)	0.28
Pfirschmann L5-S1 $\geq 3$ , n (%)	75 (24.5)	6 (22.2)	0.79
HIZ L3-L4, n (%)	5 (1.6)	0 (0.0)	0.5
HIZ L4-L5, n (%)	45 (12.5)	0 (0.0)	0.32
HIZ L5-S1, n (%)	62 (20.3)	3 (11.1)	0.25
Protrusion L3-L4, n/ (%)	6 (2.0)	0 (0.0)	1.00
Protrusion L4-L5, n (%)	21 (6.9)	0 (0.0)	0.39
Protrusion L5-S1, n (%)	39 (12.7)	1 (3.7)	0.22
Extrusion L3-L4, n (%)	2 (0.6)	0 (0.0)	1.00
Extrusion L4-L5, n (%)	18 (5.9)	2 (7.4)	0.67
Extrusion L5-S1, n (%)	26 (8.5)	3 (11.1)	0.72
Modic L3-L4, n (%)			0.09
- 1	2 (0.6)	0 (0.0)	
- 2	1 (0.3)	1 (3.7)	
- 3	0 (0.0)	0 (0.0)	
Modic L4-L5, n (%)			0.70
- 1	4 (1.3)	0 (0.0)	
- 2	4 (1.3)	0 (0.0)	
- 3	0 (0.0)	0 (0.0)	
Modic L5-S1, n (%)			0.41
- 1	7 (2.3)	1 (3.7)	
- 2	3 (1.0)	1 (3.7)	
- 3	0 (0.0)	0 (0.0)	
Sacral horizontal angle, °, mean $\pm$ SD	39.0 $\pm$ 9.2	42.2 $\pm$ 8.9	0.09
Lumbosacral angle, °, mean $\pm$ SD	14.6 $\pm$ 4.6	14.0 $\pm$ 4.6	0.45
Lumbar lordosis, °, mean $\pm$ SD	52.4 $\pm$ 13.2	58.9 $\pm$ 11.4	0.009

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5 HIZ, high-intensity zone; SD, standard deviation

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1 **Table 4.** Associations of scoliosis and radiographic and/or MRI signs suggesting axSpAat  
 2 baseline

	No scoliosis (n=362)	Scoliosis (n= 28)	<i>P</i> value
<b>Sacroiliac joints</b>			
New York criteria, radiographs	61/327 (18.6%)	8/28 (28.6%)	0.20
ASAS criteria, MRI, mean±SD	102/322 (31.7%)	12/28 (42.8%)	0.23
SPARCC score, MRI, mean±SD (n=640)	3.8±8.0	4.4±7.1	0.20
<b>Spine</b>			
mSASSS score, radiographs, mean±SD (n=640)	0.4±1.7	1.2±3.5	0.48
SPARCC score, MRI, mean±SD (n=651)	5.0±9.3	6.4±8.9	0.06
BASRI , radiographs mean±SD (n=651)	0.2±0.7	0.5±1.2	0.65

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 4 SPARCC, SPondyloArthritis Research Consortium of Canada score; mSASSS, modified Stoke  
 5 Ankylosing Spondylitis Spinal Score; BASRI, Bath Ankylosing Spondylitis Radiology Index

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Supplementary table 1: Description of patients of this study and the whole DESIR cohort

Characteristics	Patients in our study (n=362)	Patients from the DESIR cohort (n=708)
Age (years), mean±SD	33.2 ± 8.4	33.8 ± 8.6
Males, n (%)	178 (49.2%)	327 (46.2%)
BMI (m/kg <sup>2</sup> ), mean±SD	24.1±4.3	24.0 ± 4.6
Low-back pain, <sup>a</sup> n (%)	321 (88.7%)	(67.1%)
Buttock pain, <sup>a</sup> n (%)	263 (72.7%)	(39.6%)
Morning stiffness (Berlin criteria), n/N (%)	329 (90.9%)	623 (88.0%)
Nocturnal pain (Berlin criteria), n/N (%)	319 (88.1%)	630 (89.0%)
Modified Schober test (10+Xcm), mean±SD	3.7 ± 1.1	3.7 ± 1.3
Finger-floor distance (cm), mean±SD	13.0 ± 12.9	13.2 ± 13.0
HLA B27 positivity, n (%) (n=674)	224 (61.9%)	(57.3%)
ASAS criteria, n (%) (n:669)	251 (69.3%)	447 (63.1%)
Confidence in a diagnosis of SpA at baseline, <sup>b</sup> mean±SD	7.4 ± 2.1	6.8 ± 2.6