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INCREASED PREVALENCE OF SCOLIOSIS IN PSORIATIC ARTHRITIS: A CROSS-SECTIONAL CASE-CONTROL STUDY

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Abstract

Aim: Psoriatic arthritis (PsA) is expected to cause an increased risk of scoliosis because it affects the axial skeleton asymmetrically. In this study, we compared the frequency of scoliosis in PsA patients with that in healthy controls (HC) and axial spondyloarthritis (axSpA) patients. Thus, we aimed to explore whether scoliosis might be a clinical feature of PsA and to assess its potential role in differentiating PsA from axSpA.

Material and Methods: The study included 60 PsA patients, 60 axSpA patients and 40 HC. All individuals in the study were assessed for the presence of scoliosis by physical examination. Scoliosis radiography was performed in those with a positive scoliosis test on physical examination. The Cobb angle was measured using the appropriate method. A two-tailed significance level of 0.05 was considered in all analyses.

Results: Within this research, the frequency of scoliosis in PsA patients was compared with the axSpA and HC groups. The Cobb angle value was notably higher in the PsA group compared to axSpA and HC ($p=0.006$ and $p=0.007$, respectively). On physical examination, scoliosis findings and coronal spinal curvature, were observed at elevated rates in the PsA group relative to the other two groups ($p>0.05$ for all, indicating no statistical significance). Scoliosis was more frequent in the PsA group than in the axSpA group ($p=0.046$). All scoliosis cases in PsA were in mild or moderate severity.

Conclusion: Both the frequency of scoliosis and Cobb angle values were greater in PsA than those in axSpA. This outcome may be associated with the asymmetric involvement of lateral spinal structures typical of PsA. Overall, these results indicate that scoliosis could serve as a supportive marker for PsA and may aid in differentiating PsA from axSpA.

Keywords: Psoriatic arthritis, axial spondyloarthritis, scoliosis

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INTRODUCTION

Psoriatic arthritis (PsA) is a chronic inflammatory disorder that presents with a heterogeneous clinical spectrum and is associated with psoriasis (Pso) (1). The worldwide prevalence of PsA is estimated at 112 cases per 100,000 adults, affecting both men and women equally. It most frequently occurs in individuals aged 30-60 years. PsA develops in approximately 30% of patients with Pso (1,2), and can result in widely varying clinical manifestations, which often contributes to delays in diagnosis and management (3).

PsA may lead to peripheral and axial involvement. Axial involvement, which is 5-28% at the time of diagnosis, may increase up to 70% in the later stages (1). In addition to sacroiliac joints and spines, inflammation findings have been demonstrated in facet joints, ligaments, capsules, costovertebral and costotransverse joints, and entheses (3). In axial PsA, active inflammatory and structural changes, including asymmetric inflammation, erosion and osteoproliferation, may be observed in the sacroiliac joints and spine (3-7). Unlike ankylosing spondylitis, axial involvement in PsA is frequently asymmetric (3-6).

Scoliosis is usually defined as spinal curvature in the coronal plane. However, scoliosis is a more complex three-dimensional problem involving sagittal and horizontal planes (8,9). In addition to adolescent idiopathic scoliosis, adult scoliosis is an important health problem (9-12). Asymmetrical damage to the structures forming the spine, such as discs and facet joints, predisposes individuals to the development and progression of scoliosis (13,14).

Rheumatic inflammatory diseases are expected to lead to an increase in posture disorders due to their effects on the musculoskeletal (MSK) system. There are few studies investigating the presence of scoliosis in rheumatic diseases (15-22). PsA causes asymmetrical inflammatory and structural alterations in the spine and sacroiliac joints. Furthermore, it can asymmetrically involve lateral structures such as the facet joints. These observations indicate that patients with PsA might have an increased risk of developing scoliosis. To date, no studies have specifically explored the association between PsA and scoliosis in the literature.

We hypothesized that individuals with PsA are more likely to develop coronal plane-dominant postural abnormalities and scoliosis. To investigate this, we assessed the prevalence of scoliosis in PsA patients and compared the findings with those from healthy controls (HC) and patients with axial spondyloarthritis (axSpA).

MATERIAL AND METHODS

This study was approved by the İnönü University Faculty of Medicine Clinical Research Ethics Committee (approval no: 2024/08, date: 10.01.2024). All procedures were carried out in accordance with the principles of the Declaration of Helsinki (1964). Written informed consent was obtained from all participants.

Study Design and Participants

This cross-sectional case-control study was carried out to assess the presence of scoliosis in 60 consecutive patients with PsA, 60 patients with axSpA, and 40 HC who attended the Internal Medicine Rheumatology Outpatient Clinic of İnönü University, Turgut Özal Medical Centre, in 2024.

Hypothesis and Sample Size Calculation

The primary hypothesis of this research was that the prevalence of scoliosis would be markedly higher in PsA patients in comparison to both axSpA patients and HC. The alternative hypothesis suggested that there would be a meaningful difference in scoliosis prevalence between the axSpA cohort and the control group. The necessary sample size was calculated through a power analysis that was carried out according to the assumptions of the study.

Inclusion and Exclusion Criteria

Patients aged 18-65 years along with HC were enrolled in the study. PsA cases fulfilled the ClASsification criteria for Psoriatic ARthritis (CASPAR) classification criteria, while axSpA cases met the 2009 Assessment of SpondyloArthritis International Society classification criteria. Individuals with axial PsA were not considered within the axSpA group. Patients with features suggestive of axial PsA were excluded from the axSpA group. Patients diagnosed with PsA according to the CASPAR criteria were not included in the axSpA group. The differentiation was made based on peripheral joint involvement patterns and imaging findings, including asymmetric sacroiliitis and non-marginal syndesmophytes. Exclusion criteria consisted of pregnancy, as well as neurological, traumatic, or other systemic conditions that could result in spinal deformities.

Scoliosis Assessment Methods

All individuals enrolled in the study were examined for the presence of scoliosis by physical assessment. Scoliosis radiography was performed in individuals with a positive scoliosis test on physical examination. Radiological evaluation was performed with posteroanterior spine radiography and the Cobb angle was

measured with the appropriate method. Individuals with a Cobb angle of 10° and above were defined as having scoliosis. Those with Cobb angle between 10° and 20° were classified as mild scoliosis, 20-40° as moderate scoliosis, and >40° as severe scoliosis.

Statistical Analysis

The statistical procedures were conducted with IBM SPSS Statistics for Windows, version 26.0 (Armonk, NY, USA). Normality was assessed with the Shapiro-Wilk test and homogeneity of variances with Levene's test. Normally distributed variables were presented as the mean ± standard deviation and were compared using one-way ANOVA followed by Tukey's post-hoc test. Non-normally distributed variables were shown as median (minimum-maximum) and assessed using the Kruskal-Wallis test with Bonferroni-adjusted pairwise comparisons. Categorical variables were presented as counts and percentages, and compared using Pearson chi-square, continuity-corrected chi-square, or exact chi-square tests as appropriate, with Bonferroni correction for multiple comparisons. In the tables, statistically significant group differences were indicated with different superscripts (a,b) following APA style. Correlations between quantitative variables were examined using Spearman's rank correlation. A p-value <0.05 was considered statistically significant.

RESULTS

Demographic Information or Baseline Characteristics

Demographic, clinical, and laboratory data of all study groups are summarised in Table 1.

Scoliosis Data

A marked difference was observed among the groups (PsA, axSpA, and HC) regarding scoliosis positivity on examination. The PsA group showed a higher frequency of scoliosis compared to both the axSpA and HC groups. In contrast, no clear difference was detected between the axSpA and HC groups in terms of scoliosis presence on examination (p>0.05) (Table 2).

There was a significant difference between the groups (PsA, axSpA and HC) in terms of the presence of scoliosis (Cobb angle ≥10.0) as seen on scoliosis radiograph. The presence of scoliosis on radiograph was more prevalent in the PsA group compared to the axSpA group. However, there was no significant difference between the PsA and HC groups in terms of the presence of scoliosis on radiograph (p>0.05). In addition, there was no significant difference between axSpA and HC groups in terms of the presence of scoliosis (p>0.05) (Table 2). Five (62.5%) of the scoliosis cases in the PsA group had mild scoliosis and three (37.5%) had moderate scoliosis. All scoliosis cases in the axSpA and HC groups were mild.

A clear difference was detected among the groups in terms of the median Cobb angle. The PsA group had a higher median Cobb angle compared to the axSpA and HC groups (p=0.006 and p=0.007, respectively). However, no difference was observed between the PsA and HC groups regarding median Cobb values (p=1.000) (Table 2).

Subgroup Analyses for PsA Patients

In PsA patients, scoliosis was more common in women and those with comorbidities, both clinically and radiographically (all p<0.05). Additionally, Cobb angle showed a slight but clear positive correlation with age (r=0.337, p=0.009) and Health Assessment Questionnaire score (r=0.356, p=0.005).

DISCUSSION

This study evaluated the occurrence of scoliosis among PsA patients in comparison with axSpA patients and HC. The Cobb angle was higher in the PsA group than in the axSpA group, and HC. Findings from physical examination and coronal spinal curvature were more pronounced in the PsA group compared to the other two groups. Scoliosis was also more common in the PsA group than in the axSpA group. These results indicate that scoliosis could be a helpful feature in the differential diagnosis of PsA and axSpA.

Rheumatic inflammatory diseases may have an effect on body posture and specifically on scoliosis due to their direct effect on the MSK system. While almost all rheumatic inflammatory diseases affect peripheral synovial joints, SpA group diseases directly affect the axial skeleton. Since the SpA group affects the axial skeleton, individuals in this group are expected to have more posture deficits. Different SpA subgroups may affect different MSK regions symmetrically or asymmetrically, with different severity (23-25). PsA may exacerbate scoliosis because of asymmetrical functional, inflammatory and structural changes in axial skeletal structures (3,4,6,25).

Within this study, scoliosis was more prevalent in the PsA group. Moreover, the presence of scoliosis on examination and coronal curvature of the spine were observed at relatively greater rates in this group. In addition, while there was no study directly evaluating the frequency of scoliosis in axSpA, two indirect studies provided important insights on this topic (21,22).

For example, in the DESIR cohort, 362 patients aged 18-50 years with early inflammatory back pain were evaluated for lumbar scoliosis. The mean Cobb angle was reported as 3.2°±5.0°, and lumbar scoliosis was detected in 28 patients (7.7%); all cases were grade I or II scoliosis, with no severe scoliosis observed (21). Scoliosis showed no significant association with clinical

features, radiographic or magnetic resonance imaging-detected degenerative changes, or diagnostic confidence in axSpA. Furthermore, Cobb angle was not correlated with modified stoke ankylosing spondylitis spine score or radiographic sacroiliitis scores. These findings suggest that lumbar scoliosis is uncommon in young adults with early inflammatory back pain and does not affect axSpA classification criteria or diagnostic confidence.

In contrast, Yong et al. (22) conducted a large-scale retrospective cohort study in Taiwan, investigating the incidence and risk of axSpA in patients with scoliosis. The study included 4,261 patients with scoliosis and 21,305 age- and sex-matched controls, followed for 7 years. The incidence of axSpA was significantly higher in patients with scoliosis (141 vs. 46 per 100,000 person-years). The crude and adjusted hazard ratios were reported as 2.98 [95% confidence interval (CI), 1.87-4.73; p<0.001] and

Table 1. Demographic, clinical and laboratory characteristics of the study groups

Variable		PsA (60)	AxSpA (60)	HC (40)	p-value
Age (years), mean ± SD		46.7±10.9[a]	43.7±11.1[a]	37.4±8.1[b]	<0.001
Gender (famale/male), n (%)		40 (66.7)/20 (33.3)	37 (61.7)/23 (38.3)	19 (47.5)/21 (52.5)	0.151
BMI, mean ± SD		29.5±6.1[a]	29.3±4.8[a]	26.1±4.4[b]	0.003
Smoking, n (%)		26 (43.3)	24 (40.0)	14 (35.0)	0.707
Comorbidity, n (%)		36 (60.0)[a]	25 (41.7)[ab]	9 (22.5)[b]	0.001
Time to diagnosis (years), median (min-max)		6 (0-18)	6 (0-17)	-	0.418
Symptom duration (years), median (min-max)		9 (2-35)	10 (2-28)	-	0.271
DAS28-CRP, median (min-max)		2.33 (1.3-6.3)	-	-	-
DAPSA, median (min-max)		14.00 (2.6-67.8)	-	-	-
HAQ, median (min-max)		0.35 (0-1.40)	-	-	-
PASI, median (min-max)		0.3 (0-7.0)	-	-	-
History of psoriasis in himself		46 (76.7)	0 (0)	0 (0)	-
Involved regions	Axial, n (%)	3 (5)[a]	57 (95)[b]	-	<0.001
	Peripheral, n (%)	1 (1.7)[a]	0 (0)[a]	-	
	Axial+peripheral, n (%)	56 (93.3)[a]	3 (5)[b]	-	
Dactylitis, n (%)		5 (8.3)	0 (0)	-	0.057
Uveitis, n (%)		3 (5)	3 (5)	-	1.000
Nail attachment, n (%)		42 (70.0)	0 (0)	-	<0.001
Enthesitis, n (%)		32 (53.3)[a]	0 (0)b	1 (2.5)[b]	<0.001
ESR, median (min-max)		11 (2-45)[a]	7 (1-44)[a]	5 (2-8)[b]	0.006
CRP, median (min-max)		1 (0-14)[a]	1 (0-7)[a]	0 (0-0)[b]	<0.001

Values that do not share a letter (e.g., [a] vs. [b]) are significantly different at p<0.05 according to one-way ANOVA followed by Tukey's post-hoc test. A group labeled with two letters (e.g., [ab]) does not significantly differ from groups labeled with either of those individual letters ([a] or [b]).
PsA: Psoriatic arthritis, AxSpA: Axial spondyloarthritis, HC: Healthy controls, BMI: Body mass index, DAS28-CRP: Disease activity score-28 using C-reactive protein, DAPSA: Disease activity index for psoriatic arthritis, HAQ: Health Assessment Questionnaire, PASI: Psoriasis area and severity index, ESR: Erythrocyte sedimentation rate, SD: Standard deviation

Table 2. Scoliosis data of the study groups

Variable	PsA (n=60)	AxSpA (n=60)	HC (n=40)	p-value
Scoliosis on examination, n (%)	25 (41.7)[a]	11 (18.3)[b]	4 (10.0)[b]	0.001
Scoliosis (Cobb angle ≥10.0), n (%)	8 (13.3)[a]	1 (1.7)[b]	2 (5.0)[a,b]	0.039
Cobb angle, median (min-max)	0 (0-26.0)[a]	0 (0-10.0)[b]	0 (0-12.0)[b]	0.002

Values that do not share a letter (e.g., [a] vs. [b]) are significantly different at p<0.05 according to one-way ANOVA followed by Tukey's post-hoc test. A group labeled with two letters (e.g., [ab]) does not significantly differ from groups labeled with either of those individual letters ([a] or [b]).
PsA: Psoriatic arthritis, AxSpA: Axial spondyloarthritis, HC: Healthy controls

2.78 (95% CI, 1.74-4.43; p<0.001), respectively (22). These findings indicate a significant association between scoliosis and axSpA and highlight the need for further studies to clarify the underlying mechanisms.

The increased occurrence of scoliosis in PsA patients compared to axSpA may be attributed to the asymmetric involvement of spinal structures characteristic of PsA, such as cervical spine alterations, asymmetric sacroiliitis, and non-marginal syndesmophytes (3). This asymmetry may lead to uneven mechanical loading, contributing to spinal deformity, consistent with the pathophysiology of adult scoliosis. MSK pathologies that destabilize the spine—such as disc, facet joint, or ligament damage—can cause segmental instability and asymmetric degeneration, creating a vicious cycle of deformity and progression (11,12). The presence of these mechanisms in PsA supports the higher scoliosis frequency observed in our study.

The observation of relatively less scoliosis was observed in the axSpA group in our study may be due to this disease affecting the spinal structures predominantly symmetrically and causing loading in the sagittal plane. Symmetrical marginal thin syndesmophytes are frequently observed in ankylosing spondylitis (3). This suggests that axial PsA may lead to multiplanar and especially coronal posture disorders , despite the typical posture disorder (cervical flattening, increase in dorsal kyphosis, decrease in lumbar lordosis) developing in the sagittal plane expected in ankylosing spondylitis (3). The observation of fewer cases of scoliosis was observed in axSpA in our study seems to be compatible with the naturally expected progression of the disease.

All scoliosis cases in the PsA group were mild or moderate. In addition, scoliosis was not detected on radiographs in some of the patients who exhibited scoliosis symptoms on examination. Some of the patients with curvature on examination had mild scoliosis on radiographs. Although PsA affects the lateral structures of the spine asymmetrically in a way that predisposes to scoliosis, the body tries to compensate by bending the upper and lower parts of the spine to the opposite side to shift the centre of gravity to compensate for this. This may create new asymmetrical mechanical stress and inflammation points (11-14). In time, rough syndesmophytes and facet joint ankylosis may occur at these points (3-7). Although there is a predisposition to scoliosis in this process, pathological compensatory mechanisms formed in the progressive process may have contributed to scoliosis remaining at a certain level. In our study, although the frequency of scoliosis increased in PsA patients, the scoliosis remained at a mild or moderate level, which is consistent with our observations.

Our study revealed that scoliosis rates did not differ significantly between axSpA patients and HC. This may be because axSpA affects the lateral structures in the axial skeleton symmetrically. This predisposes individuals to the development of postural disorders in the axial plane rather than the coronal plane. The typical ankylosing spondylitis posture (“question mark” posture) in ankylosing spondylitis supports this (24,25). In radiographic axSpA, ossification of the ligaments around the spine, which develops in the late period, and development of symmetrical syndesmophytes between adjacent vertebrae or facet joint ankylosis, even if pathological, may limit the development of scoliosis by stabilising the spine (25).

Few studies have examined the occurrence of scoliosis in rheumatic diseases other than SpA. Among these studies, lumbar scoliosis was reported to have a relatively high prevalence, ranging from 16% to 42.6% in patients with rheumatoid arthritis (RA) (15-18). Epidemiological studies have shown that lumbar scoliosis is common in patients with and is influenced by age, disease activity, RA and treatment factors. Makino et al. (15) reported a prevalence of lumbar scoliosis of 32.0% among 241 RA patients evaluated by dual-energy X-ray absorptiometry, with an average Cobb angle of 13.6°±4.4° in patients with scoliosis. Multivariate analysis identified age as the only independent risk factor (15). Mochizuki et al. (16) conducted a larger cohort study of 411 RA patients and found a scoliosis prevalence of 30.7%, with age and vertebral fracture identified as factors associated with scoliosis. Finally, Yamada et al. (17) in a prospective longitudinal cohort study with a mean follow-up of 7 years, reported an incidence of scoliosis of 16% and identified inadequate control of RA as an independent risk factor for newly developed scoliosis. Collectively, these studies suggest that scoliosis in RA is not merely an age-related degenerative change but a complex process influenced by both disease activity and treatment factors. In a study of children with juvenile arthritis, scoliosis developed in 20% of the patients, and it was found to be particularly associated with leg length discrepancy; lower extremity joint inflammation was suggested as contributing to postural abnormalities in the axial skeleton (20). These findings suggest that in pediatric inflammatory arthritis, scoliosis may also result from a combination of systemic inflammation and mechanical factors. Overall, in both adult and pediatric inflammatory arthritis, scoliosis appears to be associated with age, disease control, and joint/lower extremity alignment. Studies in RA and juvenile idiopathic arthritis suggest that the systemic effects of these diseases, such as asymmetrical involvement of lower extremity joints, or osteoporotic vertebral

fractures, may contribute to the development or progression of scoliosis. However, unlike conditions with new bone formation observed in the SpA group, the absence of new bone formation in these conditions indicates that spinal deformities may follow a different course. This difference suggests that the development mechanisms of scoliosis may vary according to the course and pathophysiology of different inflammatory arthritides.

Our study is the first to investigate the presence of scoliosis in PsA patients. In addition, although there are indirect studies on scoliosis in the axSpA group, this was the first study to directly evaluate it. The inclusion of the axSpA group in addition to the HC group contributed to revealing the differences scoliosis across different SpA groups.

Study Limitations

There were some limitations in our study. Since our study was cross-sectional, it did not show how scoliosis changed during the course of the disease. The mean age of the PsA group was slightly higher than that of the other groups. Considering that the frequency of degenerative scoliosis may increase with age, this potential increase with age should be regarded as a limitation of the present study. In addition, the PsA group had higher body mass index (BMI) values compared to the HC. Given that a higher BMI may increase the likelihood of degenerative scoliosis, this factor should be considered as a potential limitation of our study. Since the number of subjects in the study groups was adjusted to test the hypothesis of the presence of scoliosis, there were limitations in analyses between subgroups, such as those related to age and gender. Conducting the study in a single centre limits the ability to generalise the findings. This study focused on PsA and axSpA patients, while other spondyloarthritis subgroups, including reactive arthritis and inflammatory bowel disease-associated SpA, were not included. This limits the generalizability of our findings to all forms of spondyloarthritis, and future studies should evaluate scoliosis across a broader spectrum of SpA subtypes. Multivariate analysis accounting for factors such as age, sex, BMI, and comorbidities was not performed. This represents a limitation in interpreting our results. To avoid unnecessary radiation exposure, radiographs were obtained only for subjects with positive physical findings; therefore, subclinical scoliosis cases might have been missed, potentially leading to an underestimation of scoliosis prevalence. To confirm these findings, future multicentre studies in different patient populations, with larger sample sizes, assessing the presence of scoliosis over long-term follow-up in PsA and other SpA groups, are needed.

CONCLUSION

In summary, the Cobb angle was notably higher in the PsA group compared to both the axSpA and HC groups. Examination and imaging, revealed higher rates of scoliosis in PsA patients than in those with axSpA. All scoliosis cases observed in the PsA group were classified as mild or moderate. These results suggest that the presence of scoliosis may be a supportive feature in PsA and could potentially contribute to differentiating PsA from axSpA, although further studies with formal diagnostic analyses are needed to confirm this.

Ethics

Ethics Committee Approval: This study was approved by the İnönü University Faculty of Medicine Clinical Research Ethics Committee (approval no: 2024/08, date: 10.01.2024).

Informed Consent: Written informed consent was obtained from all participants.

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Footnotes

Authorship Contributions

Concept: E.İ., S.Y., E.E., S.Z., Z.K., H.G.G.B., Design: E.İ., S.Y., E.E., S.Z., Z.K., M.S.A., Data Collection or Processing: E.İ., S.Y., E.E., S.Z., Z.K., Analysis or Interpretation: E.İ., S.Y., E.E., S.Z., Z.K., H.G.G.B., Literature Search: E.İ., S.Y., E.E., S.Z., Z.K., H.G.G.B., Writing: E.İ., S.Y., E.E., S.Z., Z.K., M.S.A., H.G.G.B.

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