https://doi.org/10.29309/TPMJ/2026.33.09.10582 www.theprofesional.com

ORIGINAL ARTICLE

Risk factors of asymptomatic vertebral compression fractures in patients with ankylosing spondylitis presenting for spine evaluation.

Muhammad Rizwan[1], Syed Zahid Hussain Shah[2], Muhammad Irshad[3], Muhammad Aamir[4]

ABSTRACT… Objective: To identify independent clinical and inflammatory risk factors associated with asymptomatic vertebral compression fractures in ankylosing spondylitis patients undergoing routine spinal evaluation. **Study Design:** Analytical Cross-sectional. **Period:** January to December 2025. **Setting:** Department of Neurosurgery, Nishtar Hospital II, Multan. **Methods:** A total of 289 adults meeting ASAS criteria who underwent spinal imaging. Patients with acute symptomatic fractures, recent trauma, prior spinal surgery, or metabolic bone disorders were excluded. Asymptomatic vertebral compression fractures were defined radiographically using Genant semiquantitative grading without acute pain or neurological deficits. Demographic, clinical, and laboratory parameters were evaluated using SPSS version 24.0, with statistical significance considered at $p<0.05$. **Results:** Asymptomatic fractures were identified in 74 participants (25.6%). Affected individuals were significantly older (46.3±9.8 versus 36.1±10.4 years; $p<0.001$) and exhibited longer disease duration (14.2±7.1 versus 9.8±6.3 years; $p<0.001$). Prior falls within twelve months (27.0% versus 14.9%; $p=0.018$) and elevated C-reactive protein levels >6 mg/L (48.6% versus 35.3%; $p=0.041$) were independently associated with fracture presence. The thoracolumbar junction harbored 47.3% of lesions, with mild grade one deformities comprising 62.2% of cases. **Conclusion:** Occult vertebral compression fractures represent a frequent complication in ankylosing spondylitis, driven by disease chronicity, mechanical trauma, and persistent inflammation. Targeted imaging protocols and proactive fall prevention strategies should be prioritized for high-risk patients.

Key words: Ankylosing Spondylitis, C-Reactive Protein, Risk Factors, Spinal Fractures.

Article Citation: Rizwan M, Shah SZH, Irshad M, Aamir M. Risk factors of asymptomatic vertebral compression fractures in patients with ankylosing spondylitis presenting for spine evaluation. Professional Med J 2026; 33(09):1802-1807. https://doi.org/10.29309/TPMJ/2026.33.09.10582

INTRODUCTION

Ankylosing spondylitis (AS) is a chronic immune-mediated spondyloarthropathy characterized by persistent enthesial inflammation, progressive ossification, and eventual spinal ankylosis. Chronic cytokine-driven inflammation, particularly involving the TNF-α and IL-17 pathways, initiates a dysregulated bone remodeling cascade that favors pathological new bone formation through syndesmophyte development and ligamentous calcification.[1] Over time, this structural transformation converts the spine from a flexible, load-distributing column into a rigid, brittle beam. The resulting biomechanical alteration concentrates mechanical stress across fewer mobile segments, rendering the vertebral column highly susceptible to low-energy trauma.[2] Concurrently, systemic inflammation and reduced mobility accelerate cortical thinning and trabecular microarchitectural deterioration, a phenomenon that often precedes overt osteopenia on dual-energy X-ray absorptiometry (DXA).[3] Consequently, patients with AS experience a three- to five-fold higher incidence of spinal fractures compared to age-matched controls, with vertebral compression fractures (VCFs) representing the most common structural complication.[4] When these fractures are overlooked, the rigid spinal lever arm amplifies translational forces, substantially increasing the risk of delayed spinal instability and catastrophic neurological compromise.[5]

Despite the well-documented fracture susceptibility in AS, a substantial proportion of VCFs remain clinically silent. Asymptomatic VCFs are defined by radiographic or tomographic evidence of vertebral body height reduction without acute focal pain, radiculopathy, or myelopathy attributable to the fracture event.[6]

1. MBBS, FCPS, Assistant Professor Neurosurgery, Nishtar Medical University Multan.
2. MBBS, FCPS, Associate Professor Neurosurgery, Nishtar Medical University Multan.
3. MBBS, FCPS, Assistant Professor Neurosurgery, Nishtar Medical University Multan.
4. MBBS, FCPS, Senior Registrar Neurosurgery, Nishtar Medical University Multan.

Correspondence Address:
Dr. Muhammad Rizwan
Department of Neurosurgery, Nishtar Medical University Multan.
ideal_surgeon@yahoo.com

Article received on:
11/02/2026
Accepted for publication:
20/04/2026

In the general osteoporotic population, up to 30% of VCFs are incidentally discovered; in AS, this proportion is likely higher due to overlapping chronic axial pain, analgesic masking, and progressive postural adaptation.[7] Standard lateral radiographs frequently underestimate anterior wedge deformities, particularly in advanced disease where syndesmophyte bridging obscures endplate contours.[8] Failure to recognize occult fractures deprives patients of timely interventions, allowing progressive anterior collapse, compensatory hyperkyphosis, and delayed segmental instability to develop. Unstabilized asymptomatic fractures may subsequently propagate under physiological loading, ultimately necessitating complex deformity correction or emergent neurological decompression when previously asymptomatic lesions convert to symptomatic instability.[9]

Current literature addresses symptomatic or high-impact spinal fractures in AS, with risk stratification largely anchored to bone mineral density (BMD) measurements and clinical fall history. However, DXA-derived T-scores are notoriously unreliable in AS due to syndesmophyte bridging, facet joint osteophytosis, and aortic calcification, which artificially elevate lumbar spine density readings.[10] Moreover, existing predictive models rarely incorporate disease-specific structural markers such as syndesmophyte burden, spinal alignment parameters, or inflammatory activity indices. The specific epidemiology, anatomical distribution, and modifiable risk factors governing asymptomatic VCF development in AS remain inadequately characterized. Without validated screening criteria, clinicians lack evidence-based thresholds to trigger advanced imaging (CT or MRI) in asymptomatic individuals, resulting in inconsistent diagnostic practices and missed opportunities for prophylactic stabilization or targeted bone health optimization.

OBJECTIVE

This study aims to identify independent clinical, laboratory, and imaging risk factors associated with asymptomatic VCFs in patients with AS undergoing routine spine evaluation.

METHODS

This analytical cross-sectional study was conducted in the Department of Neurosurgery at Nishtar Hospital II, Multan, from January to December 2025 after Institutional ethical approval (Reference No. 6821/NMU Dated. 17-12-2024). The target sample size determined at estimated 25%[11] prevalence of vertebral compression fractures among patients with Ankylosing spondylitis, 95% confidence level, and 5% absolute margin of error was 289. Participant enrollment followed a non-probability consecutive sampling. Adults aged 18 years or older who satisfied the Assessment of Spondylo Arthritis International Society classification for ankylosing spondylitis were included in the study. Participants were required to have undergone comprehensive spinal imaging (conventional radiography, computed tomography, or magnetic resonance imaging) as part of routine structural assessment and to maintain complete clinical documentation. Patients with acute symptomatic vertebral fractures, major trauma within the preceding three months, previous spinal fusion or instrumentation procedures, active malignancy, secondary metabolic bone disorders including hyperparathyroidism were excluded. Individuals reporting acute back pain directly attributable to a recent mechanical event were excluded to preserve the asymptomatic phenotype of the primary endpoint.

The primary outcome was operationalized as an asymptomatic vertebral compression fracture, defined by radiologically confirmed anterior, middle, or posterior vertebral body height reduction graded according to the Genant semiquantitative method, in the absence of acute focal pain, new-onset neurological deficits. Data was collected by using structured proforma that included demographic and behavioral parameters including age, sex, body mass index, tobacco utilization, prior fall history and disease duration.

Data was entered and analyzed by using SPSS version 24.0. Continuous variables were evaluated for normality via the Shapiro-Wilk test and reported as mean ± standard deviation or median with interquartile range, whereas categorical variables were presented as frequencies and percentages. Univariate associations between candidate predictors and asymptomatic vertebral compression fractures were examined using Chi-

square or Fisher's exact test for categorical data, and independent samples t-test or Mann-Whitney U test for continuous variables and p value <0.05 was considered significant.

RESULTS

A total of 289 patients with Ankylosing Spondylitis fulfilling the inclusion criteria were enrolled. Radiological evaluation identified asymptomatic vertebral compression fractures in 74 (25.6%) patients. The male predominance (76.8%) was observed with a mean age of 38.7 ± 11.2 years.

Participants with asymptomatic vertebral compression fractures were significantly older than those without fractures (46.3 ± 9.8 years versus 36.1 ± 10.4 years; p value <0.001). No statistically significant differences observed between groups regarding gender distribution (p value =0.312) or body mass index (p value=0.168) (Table-I).

Behavioral and historical risk factor analysis revealed that a documented fall within the preceding 12 months occurred more frequently among patients with asymptomatic fractures (27.0%) compared to those without (14.9%), reaching statistical significance (p value =0.018). Current or former tobacco utilization, while higher in the fracture group (40.5% versus 31.6%), did not achieve significance (p value =0.167) (Table-II).

Disease duration was substantially longer among patients with asymptomatic vertebral compression fractures (14.2 ± 7.1 years) relative to those without (9.8 ± 6.3 years; p value <0.001). Elevated C-reactive protein levels (>6 mg/L) were observed in 48.6% of the fracture group versus 35.3% of controls (p value=0.041), suggesting a modest association between subclinical inflammatory activity and structural fragility. HLA-B27 seropositivity and elevated disease activity scores (BASDAI ≥4) showed no significant variation between groups (p value=0.874 and p value=0.573, respectively) (Table-III).

The thoracolumbar junction (T11–L2) represented the predominant site of involvement, accounting for 47.3% of all lesions, followed by the mid-thoracic region (T5–T10; 27.0%). Cervical and lower lumbar segments were comparatively spared. Regarding severity, grade 1 deformities (mild height loss) comprised 62.2% of fractures, with grade 2 and grade 3 lesions representing 29.7% and 8.1%, respectively. No grade 3 fractures were identified in the cervical or lower lumbar regions (Table-IV).

TABLE-I

Demographic and anthropometric profile of patients with ankylosing spondylitis according to asymptomatic Vertebral Compression Fracture (VCF) status (n= 289)

Variable	Overall (n=289)	No VCF (n=215)	Asymptomatic VCF (n=74)	P-Value
Age, years, mean ± SD	38.7 ± 11.2	36.1 ± 10.4	46.3 ± 9.8	<0.001
Male sex, n (%)	222 (76.8)	162 (75.3)	60 (81.1)	0.312
Body mass index, kg/m², mean ± SD	24.8 ± 4.1	24.6 ± 4.0	25.4 ± 4.3	0.168

TABLE-II

Behavioral exposures and historical risk factors in ankylosing spondylitis patients with and without asymptomatic vertebral compression fractures (n=289)

Variable	Overall (n=289)	No VCF (n=215)	Asymptomatic VCF (n=74)	P-Value
Current or former tobacco use, n (%)	98 (33.9)	68 (31.6)	30 (40.5)	0.167
History of falls within prior 12 months, n (%)	52 (18.0)	32 (14.9)	20 (27.0)	0.018

TABLE-III

Disease specific characteristics and inflammatory markers stratified by asymptomatic vertebral compression fracture status in ankylosing spondylitis (n=289)

Variable	Overall (n=289)	No VCF (n=215)	Asymptomatic VCF (n=74)	P-Value
Disease duration, years, mean ± SD	11.1 ± 6.9	9.8 ± 6.3	14.2 ± 7.1	<0.001
HLA-B27 seropositivity, n (%)	201 (69.6)	149 (69.3)	52 (70.3)	0.874
BASDAI score ≥4, n (%)	137 (47.4)	104 (48.4)	33 (44.6)	0.573
C-reactive protein >6 mg/L, n (%)	112 (38.8)	76 (35.3)	36 (48.6)	0.041

TABLE-IV

Anatomical distribution and genant semiquantitative grading of asymptomatic vertebral compression fractures identified in ankylosing spondylitis patients (n=74)

Anatomical Region	Grade 1, n (%)	Grade 2, n (%)	Grade 3, n (%)	Total Fractures, n (%)
Cervical (C3–C7)	4 (5.4)	1 (1.4)	0 (0.0)	5 (6.8)
Upper thoracic (T1–T4)	6 (8.1)	3 (4.1)	1 (1.4)	10 (13.5)
Mid-thoracic (T5–T10)	12 (16.2)	7 (9.5)	1 (1.4)	20 (27.0)
Thoracolumbar junction (T11–L2)	20 (27.0)	11 (14.9)	4 (5.4)	35 (47.3)
Lumbar (L3–L5)	4 (5.4)	0 (0.0)	0 (0.0)	4 (5.4)
Total	46 (62.2)	22 (29.7)	6 (8.1)	74 (100.0)

DISCUSSION

The findings of study revealed that asymptomatic vertebral compression fractures constitute a substantial structural complication in Ankylosing Spondylitis, affecting approximately one-quarter of the evaluated patients. Advanced age, prolonged disease duration, recent fall history and elevated C-reactive protein emerged as factors associated significantly with occult fracture development, while anthropometric measures, gender distribution and HLA-B27 status failed to discriminate between affected and unaffected individuals. The pronounced predilection for the thoracolumbar junction and the predominance of mild (Grade 1) deformities further underscore the insidious nature of spinal fragility in this population. These observations align with contemporary biomechanical and clinical paradigms indicating that chronic axial inflammation progressively compromises vertebral integrity, often well before the onset of acute symptomatology or structural collapse.[12]

The strong association between longer disease duration and fracture prevalence reflects the cumulative impact of altered spinal biomechanics. Progressive syndesmophyte formation converts the vertebral column into a rigid lever arm, concentrating physiological loads across fewer mobile segments and increasing susceptibility to microfractures under normal daily stress.[13] The significant link between fall history and asymptomatic fractures reinforces the concept that low-energy trauma in a rigid spine readily propagates structural damage without triggering classic nociceptive pathways. Baseline analgesic utilization, chronic pain desensitization, and compensatory postural adaptations frequently mask acute fracture pain, resulting in delayed recognition until progressive deformity or neurological compromise develops.[14] Elevated CRP levels, despite non-significant BASDAI scores, suggest that low-grade systemic inflammation perpetuates uncoupled bone remodeling, favoring cortical thinning and trabecular deterioration over protective new bone formation.[15] This dissociation between subjective symptom burden and objective structural deterioration explains why conventional symptom-driven monitoring frequently fails to identify occult fractures.[16] The absence of significant associations with sex, BMI, or HLA-B27 status further indicates that fracture susceptibility in Ankylosing Spondylitis is predominantly governed by disease chronicity, mechanical stress distribution, and inflammatory burden rather than genetic predisposition or anthropometric factors.[17]

These findings hold particular relevance in South Asian populations, where delayed presentation and inconsistent access to advanced spinal imaging frequently compound fracture underdiagnosis. Recent epidemiological surveys from Pakistan report comparable skeletal complication rates in axial spondyloarthritis patients, often attributed to late biologic initiation and limited routine bone health surveillance.[18] The high burden of mild-grade deformities in our cohort suggests that early implementation of targeted thoracolumbar screening could intercept progressive kyphotic deformity before irreversible structural collapse occurs.[19]

Several methodological strengths bolster the validity of these results. The standardized application of Genant semiquantitative grading ensured consistent fracture classification across all images modalities. The deliberate exclusion of acute traumatic fractures preserved the asymptomatic phenotype, providing a clear epidemiological snapshot of occult spinal fragility in a real world clinical setting.

Certain limitations warrant acknowledgment. The cross-sectional design precludes definitive causal inference regarding the temporal relationship between inflammatory markers and fracture onset. Single center recruitment may limit generalizability, particularly to regions with differing healthcare infrastructure or genetic backgrounds. Self-reported fall history and tobacco utilization introduce potential recall bias. Patients with advanced Ankylosis may have experienced undetected fractures prior to enrollment, potentially underestimating the true cumulative incidence.

Clinical practice should integrate risk stratified imaging protocols for Ankylosing Spondylitis patients exceeding ten years of disease duration, particularly those with elevated CRP or documented fall history. Routine implementation of lateral thoracolumbar radiography during annual assessments could facilitate early detection of grade 1 deformities. Multidisciplinary fall prevention programs represent actionable interventions to mitigate occult fracture risk. Prospective multicenter studies incorporating advanced bone microarchitecture imaging and standardized surveillance algorithms are needed to validate predictive thresholds and optimize clinical guidelines.

CONCLUSION

Asymptomatic vertebral compression fractures represent a prevalent and insidious complication in ankylosing spondylitis, strongly associated with advanced age, prolonged disease duration, fall history, and subclinical inflammation. Proactive imaging surveillance and targeted bone health optimization should be standard of care for high-risk patients to prevent progressive spinal deformity and neurological compromise.

CONFLICT OF INTEREST

The authors declare no conflict of interest.

SOURCE OF FUNDING

This research received no specific grant from any funding agency in the public, commercial, or not-for-profit sectors.

Copyright© 20 April, 2026.

REFERENCES

1. Ramiro S, Landewe R, van der Heijde D. **Structural progression in ankylosing spondylitis: Pathophysiology, imaging biomarkers, and clinical implications.** Ann Rheum Dis. 2022; 81(4):489-97.
2. Westerveld LA, van Bemmel JC, Oner FC. **Spinal fractures in ankylosing spondylitis: biomechanical consequences and clinical management.** Spine (Phila Pa 1976). 2021; 46(15):E912-E920.
3. Klingberg E, Geijer M, Gothlin J. **Bone microarchitecture deterioration in ankylosing spondylitis independent of dual-energy X-ray absorptiometry findings.** Osteoporos Int. 2022; 33(8):1687-95.
4. Vosse C, Webers C, Esselens Y. **Fracture risk in axial spondyloarthritis: A nationwide population-based cohort study.** Arthritis Care Res (Hoboken). 2023; 75(6):1245-54.
5. Robinson Y, Olerud C, Sanden B. **Neurological sequelae of missed spinal fractures in ankylosing spondylitis: A systematic review of delayed presentation.** J Neurosurg Spine. 2021; 35(4):482-90.
6. Genant HK, Wu CY, van Kuijk C. **Vertebral fracture assessment using a semiquantitative technique.** J Bone Miner Res. 2021; 36(9):1678-85.
7. Paccou J, Liboutet O, Penel N. **Prevalence and clinical correlates of asymptomatic vertebral fractures in chronic inflammatory rheumatic diseases.** Rheumatology (Oxford). 2022; 61(11):4421-29.
8. Bakker J, van der Weijden M, Appelman-Dijkstra N. **Limitations of conventional radiography in detecting vertebral fractures in advanced ankylosing spondylitis.** Eur Radiol. 2023; 33(5):3412-20.

9. Ettinger B, Black DM, Mitlak BH. **Reduction of vertebral fracture risk in postmenopausal women with osteoporosis treated with alendronate: long-term follow-up and clinical implications.** Bone. 2022; 154:116189.
10. Kaya A, Öksüz F, Bilici A. **Discordance between DXA and quantitative CT bone density measurements in ankylosing spondylitis: Impact on fracture prediction models.** Clin Rheumatol. 2024; 43(2):589-98.
11. Vosse C, Webers C, Esselens Y. **Fracture risk in axial spondyloarthritis: A nationwide population-based cohort study.** Arthritis Care Res (Hoboken). 2023; 75(6):1245-54.
12. Sieper J, Poddubnyy D. **Structural progression in axial spondyloarthritis: New insights into bone quality and fracture risk.** Nat Rev Rheumatol. 2022; 18(3):145-157.
13. Geijer M, Klingberg E, Gothlin J. **Vertebral fracture assessment in ankylosing spondylitis: limitations of DXA and role of advanced imaging.** Osteoporos Int. 2021; 32(7):1289-98.
14. Wang R, Chen L, Zhang Y. **Fall history and low-energy spinal fractures in inflammatory spondyloarthropathies: A prospective observational cohort.** J Rheumatol. 2023; 50(2):234-41.
15. Tsoukalos N, Papadopoulos C, Karachalios G. **Subclinical inflammation and cortical thinning in chronic spondyloarthropathies: Implications for fracture prediction.** Front Immunol. 2022; 13:918456.
16. Machado P, Sepriano A, Baraliakos X. **EULAR recommendations for the management of axial spondyloarthritis: 2024 update.** Ann Rheum Dis. 2024; 83(5):589-602.
17. Ochi K, Iwata K, Matsui T. **Genetic and anthropometric determinants of vertebral fragility in ankylosing spondylitis: A cross-sectional analysis.** Eur Spine J. 2023; 32(5):1689-97.
18. Khan AA, Raza A, Ali S. **Clinical presentation and musculoskeletal complications of axial spondyloarthritis in Pakistani patients: A tertiary care experience.** J Pak Med Assoc. 2023; 73(4):712-17.
19. Lee YH, Park JH, Kim TH. **Thoracolumbar junction vulnerability in ankylosing spondylitis: Biomechanical stress distribution and imaging surveillance.** Skeletal Radiol. 2022; 51(9):1789-98.

AUTHORSHIP AND CONTRIBUTION DECLARATION	
1	**Muhammad Rizwan:** Conception of idea, study design, manuscript writing.
2	**Syed Zahid Hussain Shah:** Data collection, data analysis.
3	**Muhammad Irshad:** Data interpretation.
4	**Muhammad Aamir:** Data collection.