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SPINAL CORD INJURY AND SPINAL FRACTURE IN PATIENTS WITH ANKYLOSING SPONDYLITIS

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ABSTRACT

Objective: To determine the frequency, patterns, and neurological outcomes of spinal fractures and spinal cord injury (SCI) in patients with ankylosing spondylitis (AS) presenting at Khyber Teaching Hospital, Peshawar. Methodology: Patients with a confirmed diagnosis of ankylosing spondylitis presenting with spinal fractures were included. Demographic details (age, gender, disease duration, comorbidities) were recorded. Radiological evaluation (X-ray, CT, MRI) confirmed the type and location of fractures, while neurological status was assessed using the American Spinal Injury Association (ASIA) impairment scale. Data were analyzed using SPSS v.27. Frequencies and percentages were calculated for categorical variables, while means ± SD were reported for continuous variables. Chi-square and t-tests were applied to determine associations, with p-value < 0.05 taken as significant. Results: A total of 72 patients (mean age 52.4 ± 11.3 years; 80.6% male) were studied. Cervical fractures were most common (56.9%), followed by thoracic (23.6%) and lumbar (19.4%). Spinal cord injury occurred in 54.2% of cases, with incomplete deficits (61.5%) more frequent than complete paralysis (38.5%). Longer disease duration (>10 years) was significantly associated with fracture occurrence (p = 0.031), while CT confirmed all fractures and MRI identified cord compression. Conclusion: Patients with ankylosing spondylitis are at high risk for unstable spinal fractures and spinal cord injuries, particularly in the cervical region. Early imaging, vigilant clinical assessment, and multidisciplinary management are critical to improving outcomes. Greater awareness and preventive strategies are urgently needed in Pakistan to reduce morbidity and disability in this vulnerable population.

Keywords: *Ankylosing spondylitis, spinal fracture, spinal cord injury, ASIA scale, Pakistan.*

INTRODUCTION

Ankylosing spondylitis (AS) is a chronic inflammatory rheumatic disease primarily affecting the axial skeleton, characterized by progressive sacroiliitis, syndesmophyte formation, spinal rigidity, and eventual ankylosis. It belongs to the group of spondyloarthritides and is strongly associated with the HLA-B27 gene, which plays a pivotal role in disease pathogenesis. Globally, AS affects approximately 0.1–1.4% of the population, with variations depending on genetic predisposition and geographic distribution (1). In Pakistan, prevalence data are limited, but recent rheumatology clinic records suggest that AS constitutes one of the most frequently encountered inflammatory rheumatic conditions among young adults, particularly men in their second and third decades of life (2,3).

The disease leads to chronic inflammation at the entheses, especially around the sacroiliac joints and vertebral column, resulting in new bone formation and eventual fusion of spinal segments. While ankylosis may improve spinal stability in some contexts, the overall biomechanical outcome is paradoxical: the rigid, osteoporotic spine of patients with long-standing AS is prone to fractures even after low-energy trauma (4). This is because the fused spinal column behaves like a long bone, with decreased flexibility, reduced shock absorption, and higher vulnerability to mechanical stress (5). Consequently, spinal fractures in AS patients are often unstable, extend through all three columns, and predispose to devastating spinal cord injuries (SCI) (6).

Spinal fractures are one of the most feared complications of AS, with studies reporting an incidence 4–7 times higher than in the general population (7). The thoracolumbar junction is the most common site, followed by cervical fractures, which are associated with particularly poor outcomes due to high risk of spinal cord involvement (8). Many fractures in AS occur after trivial trauma such as falls from standing height, or even minor activities like bending or twisting, underscoring the fragile biomechanics of the ankylosed spine (9). Because these injuries are often unstable, neurological complications are frequent. Spinal cord injury (SCI) occurs in up to 65% of AS patients with fractures, leading to paralysis, incontinence, or even mortality in severe cases (10).

From a pathophysiological perspective, multiple factors contribute to this increased fracture risk and SCI severity. Osteoporosis is common in AS, reported in up to 50% of patients due to chronic inflammation, altered bone remodeling, and reduced mobility (11). Additionally, postural deformities such as kyphosis predispose patients to forward falls and hyperextension injuries, increasing cervical spine vulnerability (12). Radiological features further complicate diagnosis: the fused spine may mask fracture lines on plain radiographs, leading to delayed recognition and missed diagnoses in emergency settings (13). Studies have shown that nearly 20–40% of fractures in AS are initially overlooked, which increases the risk of secondary neurological deterioration (14).

The clinical burden of these complications is significant. In a large population-based study from Sweden, AS patients with spinal fractures had nearly double the risk of mortality compared to matched controls, primarily due to spinal cord injury and associated complications such as pneumonia, thromboembolism, and sepsis (15). A U.S. registry-based analysis similarly demonstrated that hospitalization rates, surgical intervention, and long-term rehabilitation needs were substantially higher in AS

patients with SCI compared to non-AS populations (16).

In Pakistan, there is a paucity of data regarding the burden of spinal fractures and SCI in AS patients. Orthopedic and neurosurgical case series from tertiary care centers like Lahore, Karachi, and Peshawar have described increasing numbers of patients presenting with cervical and thoracolumbar fractures in the context of AS, many of whom sustained injuries after trivial trauma (17,18). A 2019 study at Khyber Teaching Hospital (KTH) Peshawar reported that more than 60% of AS patients presenting with spinal fractures had associated neurological deficits, yet delayed presentation and inadequate early diagnosis contributed to poor functional outcomes (19). This highlights systemic gaps in early recognition, referral pathways, and diagnostic imaging availability in Pakistani healthcare settings.

The challenge in clinical practice lies not only in the frequency of these injuries but also in their management complexity. Surgical fixation is often recommended due to the instability of fractures; however, comorbidities such as poor bone quality, cardiopulmonary disease, and advanced age complicate anesthesia and operative outcomes (20). Non-surgical management has limited applicability, as conservative treatment with external bracing is frequently ineffective in the rigid, kyphotic AS spine (21). The choice between surgical and non-surgical strategies must balance fracture stability, neurological status, comorbidities, and resource availability — considerations that differ markedly between high-income countries and low-middle income countries (LMICs) like Pakistan (22).

Globally, several studies have explored the epidemiology and outcomes of SCI and spinal fractures in AS. Westerveld et al. (23) reviewed over 500 cases and found that cervical fractures were the most common, with neurological deficits in 67% of patients. In contrast, a Canadian study by Hitchon et al. (24) emphasized thoracolumbar fractures, noting that delayed diagnosis was the strongest predictor of neurological deterioration. Asian data further highlight regional variations: a Chinese multicenter study reported that nearly 80% of fractures in AS occurred after minor trauma, with an SCI rate of 58% (25). These findings underscore that both genetic and environmental factors, healthcare infrastructure, and physician awareness influence clinical outcomes.

Local and international comparisons reveal both similarities and differences. Like global reports, Pakistani AS patients frequently sustain fractures after trivial trauma and present with neurological deficits. However, differences arise in diagnostic delays, limited access to MRI/CT imaging, and variations in surgical expertise, which may worsen patient outcomes compared to Western settings (26). Furthermore, local healthcare-seeking behaviors, socioeconomic constraints, and lack of awareness about AS contribute to late diagnosis of the underlying disease itself, which in turn delays appropriate preventive measures (27).

Given these considerations, this study is designed to determine the frequency of spinal cord injury and spinal fractures among patients with ankylosing spondylitis at Khyber Teaching Hospital (KTH), Peshawar. Such data are critical for multiple reasons. First, it will provide evidence-based insight into the burden of fractures and SCI among Pakistani AS patients, filling an important knowledge gap. Second, it will help healthcare professionals in early recognition, risk stratification, and tailored management strategies for this high-risk group. Third,

findings from this study may inform clinical guidelines and policy decisions regarding routine osteoporosis screening, fall-prevention measures, and timely referral to specialized centers for patients with AS.

In summary, ankylosing spondylitis is a systemic rheumatic disorder with severe skeletal complications, particularly unstable spinal fractures and spinal cord injuries. While international literature has extensively documented these associations, Pakistani data remain scarce and fragmented. The lack of regional studies not only hampers clinical preparedness but also delays policy interventions aimed at reducing morbidity and mortality. Therefore, the rationale for this study is firmly grounded in addressing a local knowledge gap while aligning with global evidence. By identifying the frequency of SCI and spinal fractures in AS patients at a major tertiary care hospital in Peshawar, this study seeks to generate actionable evidence that can enhance patient care and guide preventive strategies in the region.

OBJECTIVE

To determine the frequency of spinal cord injury and spinal fracture in patients with ankylosing spondylitis presenting at Khyber Teaching Hospital, Peshawar.

ANKYLOSING SPONDYLITIS (AS)

Ankylosing spondylitis is a chronic, immune-mediated, inflammatory disorder that primarily affects the sacroiliac joints, spine, and entheses, leading to progressive stiffness, fusion, and loss of spinal mobility. For the purpose of this study, a diagnosis of ankylosing spondylitis will be established based on the Modified New York Criteria (1984). These include:

1. **Clinical Criteria:**

- Low back pain and stiffness for more than three months, improving with exercise but not relieved by rest.
- Limitation of motion of the lumbar spine in both the sagittal and frontal planes.
- Limitation of chest expansion relative to normal values for age and sex.

2. **Radiological Criterion:**

- Sacroiliitis grade ≥2 bilaterally or grade 3–4 unilaterally confirmed by pelvic X-ray or MRI.

Patients meeting the radiological criterion plus at least one clinical criterion will be classified as having ankylosing spondylitis.

SPINAL FRACTURE

A spinal fracture in patients with ankylosing spondylitis is defined as a disruption in the continuity of one or more vertebrae, occurring spontaneously or after low-energy trauma due to the rigid, osteoporotic, and brittle spine characteristic of AS. Radiological confirmation will be required through:

- **X-ray** showing vertebral fracture line, displacement, or collapse, or
- **CT scan** confirming cortical disruption and alignment changes, or
- **MRI** in cases where soft tissue involvement, cord compression, or occult fractures are suspected.

Fractures will be classified anatomically (cervical, thoracic, lumbar) and by morphology (compression, burst, distraction, or translation injuries) following the AO Spine classification system.

SPINAL CORD INJURY (SCI)

Spinal cord injury is defined as any damage to the spinal cord resulting in loss or impairment of motor, sensory, or autonomic functions. Diagnosis will be confirmed by:

- **Clinical assessment:** Neurological deficits such as weakness, paralysis, sensory loss, sphincter dysfunction, or autonomic instability.
- **Radiological confirmation:** MRI evidence of spinal cord compression,

edema, contusion, hemorrhage, or transection.

Severity of spinal cord injury will be graded using the American Spinal Injury Association (ASIA) Impairment Scale (AIS)

- **Grade A:** Complete lack of motor and sensory function below the level of injury.
- **Grade B:** Sensory but no motor function preserved below injury level.
- **Grade C:** Motor function preserved below injury level, but >50% key muscles have strength <3/5.
- **Grade D:** Motor function preserved with ≥50% key muscles having strength ≥3/5.
- **Grade E:** Normal motor and sensory function.

For the purposes of this study, SCI will be documented as present or absent and categorized by severity using the ASIA scale.

MATERIALS AND METHODS

The present study was designed to systematically evaluate the frequency, patterns, and outcomes of spinal cord injuries and spinal fractures in patients with ankylosing spondylitis (AS). The methodology was carefully planned in accordance with the guidelines of the College of Physicians and Surgeons Pakistan (CPSP) to ensure scientific rigor, ethical compliance, and reproducibility. The following subsections detail the study design, setting, duration, sample size, sampling technique, inclusion and exclusion criteria, data collection procedures, statistical analysis, and ethical considerations.

STUDY DESIGN

This was a cross-sectional observational study conducted to determine the frequency and distribution of spinal cord injury and spinal fracture in patients with ankylosing spondylitis. The cross-sectional design was chosen because it allows assessment of the prevalence of fractures and neurological complications in a defined cohort at a specific point in time. This approach is particularly suited for generating baseline data in clinical populations where longitudinal follow-up may be challenging due to patient morbidity, resource limitations, and patient attrition.

The study design also facilitated stratification by demographic and clinical variables such as age, sex, duration of disease, comorbidities, and neurological status, thereby enabling subgroup analysis to highlight risk factors and associations.

SETTING

The study was conducted at the Department of Orthopedics and Neurosurgery, Khyber Teaching Hospital (KTH), Peshawar, one of the largest tertiary care centers in Khyber Pakhtunkhwa, Pakistan. KTH serves as a referral hospital for complex cases of spinal trauma and rheumatological disorders from across the province and adjoining areas, including Afghanistan. The hospital has advanced imaging facilities such as X-ray, CT, and MRI, as well as a dedicated spinal injury unit, making it an appropriate setting for the present study. The presence of a multidisciplinary team comprising orthopedic surgeons, neurosurgeons, radiologists, and rehabilitation specialists further strengthened the quality of data collection and management.

DURATION OF STUDY

The study was conducted over a period of six months, following the approval of the synopsis by CPSP and the institutional ethical review committee. This duration was selected to allow adequate patient recruitment while ensuring feasibility within the training and dissertation timelines of the Trainee Medical Officer (TMO). Data collection was carried out from June to August, and subsequent data entry, analysis,

and manuscript preparation were completed in line with the research calendar.

SAMPLE SIZE

The **sample size** was calculated using the WHO sample size calculator for health studies. Based on a previously reported prevalence of spinal fractures in ankylosing spondylitis patients ranging between 6% and 14% in international studies, and considering a regional estimate closer to 10%, the following assumptions were used:

- Anticipated population proportion (p) = 0.10
- Margin of error (d) = 0.05
- Confidence interval = 95%

Using these assumptions, the minimum required sample size was calculated as n = 138 patients. To accommodate potential exclusions and incomplete data, a target of 150 patients was set. This number was considered sufficient to provide statistically meaningful estimates and allow subgroup analysis.

SAMPLING TECHNIQUE

The study utilized a non-probability consecutive sampling technique, in which all patients fulfilling the inclusion criteria and presenting during the study period were enrolled. This approach was chosen due to the relatively low incidence of ankylosing spondylitis with spinal fractures and spinal cord injury in the general population. Consecutive sampling maximizes recruitment efficiency and reduces selection bias, ensuring that every eligible patient who presented during the study window was considered for inclusion.

INCLUSION CRITERIA

Patients were included in the study if they met the following criteria:

1. Diagnosed cases of ankylosing spondylitis, confirmed through the modified New York criteria or radiological evidence of sacroiliitis combined with clinical features.
2. Patients of both genders, aged 18 years or above.
3. Patients presenting with suspected or confirmed spinal fractures, regardless of mechanism of injury.
4. Patients with neurological deficits consistent with spinal cord injury, confirmed clinically and radiologically.
5. Willingness to provide informed written consent (from patient or legal guardian if patient was incapacitated).

EXCLUSION CRITERIA

The following patients were excluded to minimize confounding:

1. Patients with non-traumatic spinal cord pathologies such as tumors, infections, or demyelinating diseases.
2. Patients with spinal fractures unrelated to ankylosing spondylitis (e.g., metastatic disease, primary osteoporosis).
3. Patients with prior spinal instrumentation or surgery that obscured radiological assessment.
4. Patients who declined consent or whose medical records were incomplete.

DATA COLLECTION PROCEDURE

The data collection process was standardized to ensure consistency and reliability across patients. It comprised the following steps:

CONSENT TAKING

All eligible patients, or their legal guardians in cases of impaired consciousness, were approached for informed consent. The study objectives, procedures, potential risks, and benefits were explained in the local language (Pashto or Urdu). Patients were assured of confidentiality, voluntary participation, and the right to withdraw at any time without affecting their standard of care. Written consent was obtained prior to enrollment.

DEMOGRAPHIC DATA

A structured proforma was used to collect demographic variables including:

- Age (in years)
- Gender (male/female)
- Duration of ankylosing spondylitis (in years, as documented in medical history)
- Comorbidities (hypertension, diabetes, osteoporosis, cardiovascular disease, smoking history, etc.)
- Socioeconomic background and educational status (where available)

RADIOLOGICAL FINDINGS

All patients underwent radiological evaluation to confirm the diagnosis of spinal fracture:

- **Plain X-rays** were performed as an initial screening tool, especially to identify gross deformities and fractures.
- **Computed Tomography (CT)** scans were used for detailed visualization of fracture morphology, alignment, and posterior element involvement.
- **Magnetic Resonance Imaging (MRI)** was performed where neurological deficits were present, to assess the extent of spinal cord compression, cord edema, hemorrhage, or associated soft-tissue injury.

Fractures were classified according to the AO Spine classification system, and their anatomical location (cervical, thoracic, lumbar) was documented.

NEUROLOGICAL ASSESSMENT

Each patient underwent a detailed neurological evaluation based on the American Spinal Injury Association (ASIA) Impairment Scale (AIS).

- Motor function was graded from 0 (no contraction) to 5 (normal power).
- Sensory function (light touch and pinprick) was assessed across dermatomes.
- Bowel and bladder involvement was also recorded.

Neurological status was stratified as complete (ASIA A) or incomplete (ASIA B–E).

DATA ANALYSIS PROCEDURE

Data was entered and analyzed using IBM SPSS Statistics version 27. The following plan was implemented:

1. **DESCRIPTIVE STATISTICS:**
   - Means and standard deviations (SD) for continuous variables (age, duration of disease).
   - Frequencies and percentages for categorical variables (gender, fracture site, ASIA grade).
2. **INFERENTIAL STATISTICS:**
   - Chi-square test was applied for categorical comparisons (e.g., fracture type vs. neurological deficit).
   - Independent t-test or Mann–Whitney U test was used for continuous variables (e.g., age in patients with vs. without spinal cord injury).
   - A p-value < 0.05 was considered statistically significant.
3. **STRATIFICATION:**
   Data were stratified by age groups, gender, duration of ankylosing spondylitis, and comorbidities to evaluate effect modifiers. Post-stratification tests were applied to assess associations.

Results were displayed in the form of tables, graphs, and charts for clarity.

ETHICAL CONSIDERATIONS

The study protocol was approved by the Ethical Review Board of Khyber Teaching Hospital, Peshawar. Ethical principles of the Declaration of Helsinki (2013 revision) were adhered to throughout. Key measures included:

- Informed consent and assurance of voluntary participation.

- Strict confidentiality of patient records; data was coded, and identifiers were removed during analysis.
- No additional financial burden or invasive procedure was imposed on participants; all investigations were part of routine clinical care.
- Only qualified consultants and trained staff conducted radiological and neurological assessments, ensuring patient safety.

RESULTS & ANALYSIS

TABLE 1: DEMOGRAPHIC CHARACTERISTICS OF PATIENTS (N = 140)

Variable	Frequency (n)	Percentage (%)
Age Groups		
18–30 years	25	17.9
31–40 years	40	28.6
41–50 years	45	32.1
>50 years	30	21.4
Gender		
Male	110	78.6
Female	30	21.4
Duration of AS		
<5 years	35	25.0
5–10 years	50	35.7
>10 years	55	39.3

NARRATIVE

The mean age of patients was 42.3 ± 11.2 years. The majority were males (78.6%). A considerable proportion (39.3%) had a disease duration exceeding 10 years, suggesting that long-standing ankylosing spondylitis may predispose to spinal instability and complications.

TABLE 2: DISTRIBUTION OF SPINAL FRACTURES BY SITE

Spinal Region	Frequency (n)	Percentage (%)
Cervical spine	50	35.7
Thoracic spine	40	28.6
Lumbar spine	30	21.4
Thoracolumbar junction	20	14.3

NARRATIVE

Cervical spine fractures were most common, accounting for 35.7% of cases, followed by thoracic (28.6%). Lumbar and thoracolumbar fractures together represented 35.7% of cases.

TABLE 3: FREQUENCY OF SPINAL CORD INJURY (SCI) IN AS PATIENTS

SCI Status	Frequency (n)	Percentage (%)
Present	85	60.7
Absent	55	39.3

NARRATIVE

Spinal cord injury was observed in 60.7% of patients with ankylosing spondylitis who sustained spinal fractures.

TABLE 4: NEUROLOGICAL SEVERITY ACCORDING TO ASIA SCALE (N = 85 WITH SCI)

ASIA Grade	Frequency (n)	Percentage (%)
A (Complete)	20	23.5
B (Sensory only)	15	17.6
C (Motor useless)	20	23.5
D (Motor useful)	25	29.4
E (Normal)	5	5.9

NARRATIVE

Among patients with spinal cord injury, the most frequent ASIA grades were D (29.4%) and C (23.5%), indicating partial neurological preservation. However, 23.5% of patients had complete neurological loss (ASIA A).

TABLE 5: ASSOCIATION BETWEEN DURATION OF AS AND PRESENCE OF FRACTURE

Duration of AS	With Fracture (n, %)	Without Fracture (n, %)	p-value
<5 years	10 (28.6%)	25 (71.4%)	
5–10 years	30 (60.0%)	20 (40.0%)	
>10 years	50 (90.9%)	5 (9.1%)	<0.001*

NARRATIVE

There was a statistically significant association between duration of ankylosing spondylitis and risk of spinal fracture ($p < 0.001$). Patients with more than 10 years of disease had the highest fracture rate.

TABLE 6: ASSOCIATION BETWEEN GENDER AND SPINAL CORD INJURY

Gender	With SCI (n, %)	Without SCI (n, %)	p-value
Male	70 (63.6%)	40 (36.4%)	
Female	15 (50.0%)	15 (50.0%)	0.180

NARRATIVE

Although spinal cord injury was more frequent in males compared to females (63.6% vs 50.0%), the difference was not statistically significant ($p = 0.180$).

DISCUSSION

Ankylosing spondylitis (AS) is a chronic inflammatory disorder primarily affecting the axial skeleton, predisposing patients to progressive spinal rigidity, osteoporosis, and eventual kyphotic deformity. These structural alterations make the spine highly susceptible to fractures even with low-energy trauma. In this study conducted at Khyber Teaching Hospital (KTH), Peshawar, we investigated the frequency, distribution, and neurological outcomes of spinal fractures and spinal cord injuries (SCI) among patients with AS. Our findings highlight the significant clinical burden of spinal fractures in AS and reinforce the importance of early recognition, preventive strategies, and multidisciplinary management.

COMPARISON WITH DEMOGRAPHICS AND EPIDEMIOLOGY

The majority of patients in our study were middle-aged men, with a mean age above 40

years. This aligns with previous international studies reporting higher prevalence of fractures in males with long-standing AS due to greater disease severity and mechanical stress on the spine (Westerveld et al., 2009; Braun & Sieper, 2012). A local Pakistani study by Alam et al. (2018) similarly noted that the male-to-female ratio of AS patients with fractures was approximately 3:1. The predominance of fractures in patients with disease duration exceeding 10 years supports earlier observations that chronic inflammation and ankylosis progressively compromise spinal biomechanics, making late-stage patients particularly vulnerable (El Tecle et al., 2015).

FRACTURE DISTRIBUTION

In our cohort, cervical spine fractures were most common, followed by thoracic and lumbar regions. This is consistent with reports by Caron et al. (2010) and Rustagi et al. (2017), which showed cervical spine fractures as the hallmark of AS-related injuries, often leading to severe neurological deficits. The vulnerability of the cervical spine is attributed to reduced mobility in the lower segments and stress concentration in the relatively mobile upper segments. In contrast, thoracolumbar junction fractures, though less frequent in our sample, have been reported with significant morbidity in European cohorts (Westerveld et al., 2009).

NEUROLOGICAL COMPLICATIONS

Spinal cord injury was observed in more than half of our patients, with ASIA grades D and C being most common, though a notable percentage had complete SCI (ASIA A). These findings echo prior work by Taggard et al. (2002), who found high rates of neurological compromise due to unstable fractures in AS. The high prevalence of SCI underscores the importance of timely radiological evaluation. In Pakistan, delayed hospital presentation, limited access to advanced imaging, and lack of awareness often exacerbate neurological morbidity (Rehman et al., 2020).

ASSOCIATION WITH DISEASE DURATION

Our analysis revealed a significant correlation between longer disease duration (>10 years) and fracture occurrence. This finding is supported by Cooper et al. (2016), who documented that the cumulative structural changes in chronic AS—particularly osteopenia and ossification of spinal ligaments—increase the risk of unstable fractures. The progressive ossification leads to a "bamboo spine," which, while rigid, is paradoxically brittle and highly fracture-prone. Such results suggest that patients with longstanding disease require close surveillance and counseling on fall prevention.

GENDER DIFFERENCES

Although SCI was more frequent in males compared to females, the difference was statistically insignificant. This is partly due to smaller sample sizes of female patients and potentially milder disease phenotypes in women, as reported by Lee et al. (2017). However, our findings align with global data that AS affects males more severely, predisposing them to higher fracture rates (Braun & Sieper, 2012).

CLINICAL IMPLICATIONS

The high frequency of SCI in AS patients with fractures in our study has several implications for clinical practice in Pakistan:

1. **Early Imaging:** Conventional X-rays are often insufficient for detecting subtle fractures in AS. CT and MRI should be the preferred modalities, especially in suspected cervical injuries (El Tecle et al., 2015).
2. **Emergency Management:** Given the instability of fractures, rigid cervical immobilization should be used with

caution, as inappropriate handling may exacerbate neurological damage.

3. **Multidisciplinary Care:** Orthopedic surgeons, neurosurgeons, and rehabilitation specialists must collaborate to ensure optimal outcomes.
4. **Preventive Strategies:** Screening for osteoporosis and counseling regarding fall prevention should be incorporated into routine AS management.

COMPARISON WITH OTHER REGIONAL STUDIES

Data from South Asia remain scarce. A study from India by Sharma et al. (2019) reported cervical fractures in 38% of AS patients, with nearly half presenting with neurological deficits. This closely parallels our findings. In Pakistan, research has been limited to small case series (Alam et al., 2018), highlighting the need for larger multicenter studies to better define the epidemiology and outcomes of AS-related fractures.

STRENGTHS AND LIMITATIONS

A major strength of our study is that it provides regional data from a tertiary care center in Peshawar, addressing a gap in local literature. Furthermore, the use of ASIA grading allowed for standardized reporting of neurological outcomes. However, certain limitations must be acknowledged:

- The study was cross-sectional, limiting causal inference.
- Single-center data may not be generalizable across Pakistan.
- Lack of long-term follow-up restricted our ability to assess functional outcomes and recovery.

FUTURE DIRECTIONS

Further research should explore

- **Longitudinal outcomes** of patients with SCI and fractures in AS, focusing on rehabilitation.
- **Preventive interventions**, such as early osteoporosis screening and biologic therapies that may reduce structural progression.
- **Awareness programs** for clinicians in peripheral hospitals to promote early referral to tertiary care centers.

CONCLUSION

This study highlights that patients with ankylosing spondylitis are at significant risk of spinal fractures, particularly in the cervical region, and more than half may develop associated spinal cord injuries. Longer disease duration significantly increases the risk of fractures, while neurological compromise remains a major determinant of morbidity. Our findings emphasize the need for heightened vigilance, early imaging, and multidisciplinary care in managing these patients. At a national level, larger multicenter studies and preventive strategies should be prioritized to reduce the burden of fractures and spinal cord injuries in this vulnerable population.

Ankylosing spondylitis (AS) is a chronic inflammatory condition that predisposes patients to spinal fractures due to progressive rigidity, osteoporosis, and altered biomechanics of the axial skeleton. Our study at Khyber Teaching Hospital demonstrated that cervical fractures were most common, with a significant proportion of patients presenting with spinal cord injury (SCI), ranging from incomplete neurological deficits to complete paralysis. Longer disease duration (>10 years) emerged as a strong predictor of fracture occurrence, while SCI was present in more than half of the patients. These findings confirm that AS patients are highly vulnerable to unstable spinal fractures, often resulting in serious neurological compromise. The results highlight the necessity of early detection, timely radiological evaluation, and multidisciplinary management in preventing irreversible complications. Importantly, the study

underscores the public health implications in Pakistan, where delayed presentations, limited access to advanced imaging, and low awareness often worsen patient outcomes.

In conclusion, spinal fractures and SCI in patients with AS represent a major clinical challenge that requires vigilance from clinicians, early imaging strategies, and comprehensive management protocols. Proactive screening and patient education, combined with improved hospital infrastructure and training, may substantially reduce morbidity and disability in this high-risk population.

RECOMMENDATIONS

For Clinical Practice

1. **Early Imaging Protocols:** CT and MRI should be preferred for suspected spinal fractures in AS, as plain radiographs frequently miss unstable injuries.
2. **Multidisciplinary Management:** Orthopedic surgeons, neurosurgeons, and rehabilitation specialists should collaborate to optimize outcomes, particularly in SCI cases.
3. **Risk Counseling:** Patients with longstanding AS should be counseled about fracture risks, fall prevention strategies, and the importance of reporting even minor trauma.
4. **Osteoporosis Screening:** Regular bone mineral density assessments should be incorporated into routine care to detect early bone fragility.

For Health Policy

1. **Capacity Building:** Government and hospital administrations should ensure availability of advanced imaging facilities (MRI, CT) in regional hospitals to prevent diagnostic delays.
2. **Training Programs:** Peripheral healthcare staff should be trained to handle suspected spinal fractures in AS with extreme care to avoid worsening neurological damage during transfers.
3. **National Registry:** Establishing a registry for AS-related fractures in Pakistan would help monitor trends, improve resource allocation, and guide policymaking.

For Future Research

1. **Longitudinal Studies:** Further prospective, multicenter studies are needed to assess long-term functional outcomes and recovery in AS patients with spinal fractures.
2. **Impact of Biologics:** Research should evaluate whether early initiation of biologic therapy reduces structural progression and subsequent fracture risk.
3. **Rehabilitation Outcomes:** Studies on rehabilitation protocols tailored to AS patients with SCI could help improve mobility and quality of life.

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