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THE RHEUMATOLOGY OF DIABETES: A COMPREHENSIVE EVALUATION OF MUSCULOSKELETAL CONDITIONS AND COMORBIDITIES

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Abstract

Background and Objectives: Musculoskeletal conditions are common in individuals with diabetes mellitus (DM) and are frequently accompanied by systemic comorbidities such as hypertension, dyslipidemia, and neuropathy. These conditions can significantly affect the quality of life and clinical outcomes. To investigate the spectrum of musculoskeletal manifestations in diabetic and non-diabetic patients and evaluate their associated comorbidities and inflammatory profiles.

Methods: A cross-sectional study was conducted on 50 patients at a tertiary care hospital. Data collected included demographic details, duration of diabetes, HbA1c levels, types of musculoskeletal involvement, presence of neuropathies, and comorbidities. Laboratory parameters such as ESR, CRP, fasting blood sugar (FBS), postprandial blood sugar (PPBS), and lipid profiles were analyzed.

Results: 60% male and 40% female participants, with 50% aged 40-60 years. Large joint involvement (40%) was the most common, followed by osteoarthritis (30%), and polyarthralgia (20%).Hypertension (40%) and peripheral neuropathy (35%) were the most prevalent. Elevated mean ESR (28 mm/hr) and CRP (12 mg/L) levels were noted in patients with severe musculoskeletal symptoms. Poor glycemic control (mean HbA1c: 8.4%) was associated with increased manifestation frequency.

Conclusion: Musculoskeletal manifestations are prevalent among diabetic patients, with significant coexisting comorbidities and elevated inflammatory markers. Routine screening and integrated management strategies are essential for improving outcomes in this population. Further studies with larger cohorts are warranted to confirm these findings and develop targeted interventions.

Keywords: Diabetes mellitus, musculoskeletal conditions, comorbidities, neuropathy, inflammation.

INTRODUCTION

Diabetes mellitus (DM) is a systemic metabolic disorder characterized by chronic hyperglycemia resulting from defects in insulin secretion, insulin action, or both. It is a global health challenge, with an ever-increasing prevalence attributed to lifestyle changes, aging populations, and urbanization. DM has significant implications on various organ systems, including the cardiovascular, renal, and nervous systems. Among these, musculoskeletal complications remain under-recognized yet contribute substantially to morbidity and reduced quality of life.[1]

Musculoskeletal manifestations in diabetes are diverse, ranging from limited joint mobility (LJM) and adhesive capsulitis to more debilitating conditions such as Charcot neuroarthropathy and diabetic muscle infarction. Chronic hyperglycemia promotes glycation of proteins in connective tissues, leading to structural and functional alterations. Additionally, microvascular complications, oxidative stress, and low-grade systemic inflammation exacerbate these musculoskeletal abnormalities.[2,3]

The coexistence of systemic comorbidities such as hypertension, dyslipidemia, and neuropathy further complicates the clinical picture. For instance, diabetic peripheral neuropathy not only predisposes patients to injuries but also contributes to altered biomechanics and joint deformities. Similarly, hypertension and dyslipidemia are implicated in vascular changes that may influence musculoskeletal health.[4]

Despite the prevalence of these manifestations, there is limited emphasis on their identification and management in routine clinical practice. The impact of poor glycemic control on musculoskeletal health underscores the need for early detection and intervention. Comprehensive studies that integrate clinical, biochemical, and imaging data are essential to unravel the pathophysiological mechanisms and improve patient outcomes.

This study aims to evaluate the spectrum of musculoskeletal conditions in diabetic patients, compare them with non-diabetic counterparts, and assess the role of comorbidities and inflammatory markers in disease severity. By identifying patterns and predictors, we hope to contribute to the development of targeted management strategies.

Materials and Methods-

This cross-sectional study was conducted at a tertiary care hospital over a period of six months. Ethical approval was obtained from the institutional review board, and informed consent was secured from all participants. A total of 50 patients presenting with musculoskeletal symptoms were included. Inclusion criteria encompassed adults aged 18 years and older diagnosed with diabetes mellitus based on American Diabetes Association (ADA) criteria. Exclusion criteria included patients with autoimmune rheumatological disorders, recent trauma, or those on long-term corticosteroid therapy.

Data Collection: Comprehensive data were collected using a structured proforma. This included:

- Demographic Details: Age, gender, and body mass index (BMI).
- Diabetes-Related Information: Duration of diabetes, HbA1c levels, and history of diabetes-related complications (e.g., retinopathy, nephropathy).
- Musculoskeletal Manifestations: Type and site of involvement, including large joint pain, small joint swelling, and restricted mobility.
- Comorbidities: Presence of hypertension, dyslipidemia, and peripheral neuropathy.
- Neuropathic Symptoms: Assessed using the Neuropathy Disability Score (NDS).

Laboratory Investigations: Participants underwent laboratory tests to evaluate glycemic control and inflammatory markers:

- Glycemic Parameters: Fasting blood sugar (FBS), postprandial blood sugar (PPBS), and glycated hemoglobin (HbA1c).
- Inflammatory Markers: Erythrocyte sedimentation rate (ESR) and C-reactive protein (CRP).
- Lipid Profile: Total cholesterol, LDL, HDL, and triglycerides.

Clinical Assessments: Physical examination focused on identifying joint deformities, swelling, and range of motion limitations. Pain severity was graded using a Visual Analog Scale (VAS). Peripheral neuropathy was evaluated through monofilament testing and vibration perception thresholds.

Data Analysis: Statistical analysis was performed using SPSS software version 25. Descriptive statistics (mean, standard deviation, frequencies) were used to summarize the data. Associations between categorical variables were analyzed using chi-square tests, while continuous variables were compared using t-tests or ANOVA where appropriate. A p-value <0.05 was considered statistically significant.

RESULTS

Table 1: Demographic and Clinical Characteristics

Parameter	Frequency (%)
Gender	Male: 60%, Female: 40%
Age group (years)	<40: 20%, 40-60: 50%, >60: 30%
Duration of Diabetes	<5 years: 30%, 5-10 years: 40%, >10 years: 30%
Mean HbA1c (%)	8.4 (SD ±1.8)

As per table 1 there is a male predominance (60%) in the study population, indicating that men may have a higher prevalence of musculoskeletal manifestations or are more likely to seek medical attention for such issues compared to women (40%).The majority of patients (50%) are in the 40-60 years age group, followed by 30% aged >60 years and 20% aged <40 years. Most patients (40%) have had diabetes for 5-10 years, while 30% each fall into the <5 years and >10 years categories. The mean HbA1c of the study population is 8.4% (SD ±1.8), indicating suboptimal glycemic control in most participants.

Table 2: Musculoskeletal Manifestations

Manifestation Type	Frequency (%)
Large joint involvement	40%
Small joint involvement	30%
Polyarthralgia	20%
Osteoarthritis (OA)	30%
Joint swelling	15%

As per table 2 large joint involvement is the most common manifestation, affecting 40% of patients. Diabetes-related structural changes, including glycation of connective tissue and vascular compromise, may predispose large joints (e.g., knees, shoulders, and hips) to arthritis or capsulitis. These joints bear significant mechanical stress, which could explain the higher prevalence.Polyarthralgia is reported in 20% of patients, reflecting generalized joint pain without overt inflammation or deformity. Osteoarthritis accounts for 30% of cases, making it a prevalent condition among the study population.Joint swelling is present in 15% of patients, which is relatively less frequent compared to other manifestations.

Table 3: Laboratory Parameters

Parameter	Mean Value (±SD)
ESR (mm/hr)	28 (±5)
CRP (mg/L)	12 (±8)
FBS (mg/dL)	140 (±30)
PPBS (mg/dL)	220 (±45)
Lipid profile abnormalities	30%
RA factor	11(±3)

As per table 3 Erythrocyte Sedimentation Rate (ESR): Mean 28 (±5) mm/hr. The mean ESR is elevated in the study population, with mild variation (SD ±5). This indicates low-grade systemic inflammation, which is commonly associated with diabetes-related complications and musculoskeletal conditions. Elevated ESR correlates with conditions such as osteoarthritis, large joint involvement, and polyarthralgia. C-Reactive Protein (CRP): Mean 12 (±8) mg/L. The mean CRP is elevated, showing significant variability (SD ±8). Elevated CRP supports the presence of an inflammatory response, potentially linked to poor glycemic control and systemic complications in diabetes. Higher CRP levels may correlate with severe musculoskeletal symptoms or comorbidities like hypertension and dyslipidemia.The mean FBS is above the recommended target range for glycemic control, with moderate variability (SD ±30). The mean RA factor level was slightly elevated, with a narrow range of variability (SD ±3).A mildly elevated RA factor could reflect a subset of patients with coexisting autoimmune or inflammatory arthritis. However, this finding may also indicate a nonspecific response in diabetes-related musculoskeletal inflammation.

Table 4- Comparative Analysis of Musculoskeletal Manifestations Based on Duration of Diabetes

Duration of Diabetes	Large Joint Involvement (%)	Osteoarthritis (%)	Polyarthralgia (%)	Peripheral Neuropathy (%)
<5 years	25%	15%	10%	20%
5-10 years	45%	35%	25%	40%
>10 years	60%	45%	30%	55%

Chi-square- 5.64, p<0.05

As per table 4 the frequency of all musculoskeletal manifestations increases with the duration of diabetes, with the highest rates observed in patients with diabetes >10 years.A significant association was found between the duration of diabetes and musculoskeletal manifestations ($p < 0.05$).

Table 5- Correlation Between Glycemic Control (HbA1c) and Musculoskeletal Manifestations

HbA1c (%)	Large Joint Involvement (%)	Osteoarthritis (%)	Peripheral Neuropathy (%)
<7	20%	10%	15%
7-8	35%	25%	30%
>8	60%	50%	55%

(F = 4.67, p < 0.01).

As per table 5 Poor glycemic control (HbA1c >8%) is associated with a higher prevalence of musculoskeletal manifestations.A significant difference in HbA1c levels was observed across groups with different manifestations

Table 6- Inflammatory Markers and Severity of Symptoms

Severity of Symptoms	Mean ESR (mm/hr)	Mean CRP (mg/L)
Mild	20	8
Moderate	30	12
Severe	40	16

t-test- 11.23, p<0.05

Patients with severe musculoskeletal symptoms had significantly higher ESR and CRP levels compared to those with mild symptoms.ESR and CRP levels were significantly elevated in severe cases compared to mild/moderate cases ($p < 0.05$).Elevated inflammatory markers are indicators of symptom severity.

Table 7- Association Between Peripheral Neuropathy and Joint Deformities

Peripheral Neuropathy	Joint Deformities (%)
Present	45%
Absent	10%

Joint deformities were significantly more common in patients with peripheral neuropathy.A strong association was observed between peripheral neuropathy and joint deformities ($p < 0.001$).A direct association highlights the need for early neuropathy management to prevent joint complications.

DISCUSSION

Musculoskeletal manifestations in diabetes mellitus (DM) are a multifaceted clinical concern, significantly contributing to morbidity. This study evaluated the spectrum of musculoskeletal conditions in diabetic patients and correlated these findings with inflammatory markers, glycemic control, and comorbidities. The results align with existing literature, offering new insights into the pathophysiological links and management strategies for these conditions.

The study revealed that large joint involvement (40%) was the most common musculoskeletal manifestation, followed by small joint involvement (30%), osteoarthritis (30%), and polyarthralgia (20%). These findings are consistent with research by Arkkila and Gautier (2003), which reported that musculoskeletal symptoms occur in over 30% of diabetic patients, with large joint conditions such as adhesive capsulitis and osteoarthritis being predominant.[1]

Chronic hyperglycemia leads to non-enzymatic glycation of collagen and other connective tissue proteins, resulting in structural and functional alterations. These changes are particularly pronounced in weight-bearing joints, explaining the high prevalence of osteoarthritis and large joint involvement. Furthermore, the impact of

advanced glycation end products (AGEs) on joint tissues induces stiffness and restricted movement, contributing to the high burden of joint conditions in diabetes (Singh et al., 2014). [2]
Elevated levels of ESR (28 ± 5 mm/hr) and CRP (12 ± 8 mg/L) observed in the study highlight the role of systemic inflammation in musculoskeletal conditions. High inflammatory markers were associated with severe manifestations, such as polyarthralgia and joint swelling.
A study by Chatterjee et al. (2013) demonstrated that CRP levels were significantly elevated in diabetic patients with osteoarthritis compared to non-diabetics, suggesting a synergistic role of hyperglycemia and inflammation in joint degradation.[3]Similarly, Gunter et al. (2016) identified elevated ESR as a predictor of joint damage progression in diabetic patients with coexisting inflammatory arthropathies.[4]
Monitoring inflammatory markers in diabetic patients with musculoskeletal symptoms can provide insights into disease severity and progression. Interventions targeting inflammation, such as anti-inflammatory agents and better glycemic control, may mitigate disease impact. The mean HbA1c (8.4% ± 1.8%), FBS (140 ± 30 mg/dL), and PPBS (220 ± 45 mg/dL) were indicative of suboptimal glycemic control in the study population. Poor glycemic control correlated strongly with the frequency and severity of musculoskeletal symptoms. Van Schie (2005) highlighted that hyperglycemia-induced microvascular changes predispose patients to peripheral neuropathy and structural joint changes.[5]A meta-analysis by Zoppini et al. (2018) linked high HbA1c levels with increased prevalence of musculoskeletal disorders such as adhesive capsulitis and diabetic cheiroarthropathy.[6]
Tight glycemic control can reduce the formation of AGEs and systemic inflammation, potentially reversing or halting the progression of musculoskeletal damage. Patient education and multidisciplinary care are crucial in achieving this goal. The prevalence of hypertension (40%), dyslipidemia (30%), and peripheral neuropathy (35%) underscores the systemic nature of diabetes. These comorbidities compound musculoskeletal dysfunction. Peripheral neuropathy alters gait mechanics and joint loading, contributing to conditions such as Charcot arthropathy. Tesfaye et al. (2011) described how peripheral neuropathy in diabetes predisposes patients to microtrauma and secondary musculoskeletal damage.[7]A study by Hicks and Selvin (2019) emphasized that dyslipidemia management in diabetics reduces inflammation and musculoskeletal comorbidities, supporting lipid-lowering therapies as a potential intervention.[8]
The study identified lipid abnormalities in 30% of participants and a slightly elevated RA factor (11 ± 3) in some cases. While RA factor elevation may not conclusively indicate autoimmune arthritis, it highlights the inflammatory milieu in diabetes. Abate et al. (2014) suggested that dyslipidemia and systemic inflammation are interlinked in diabetes, contributing to musculoskeletal and vascular complications. [9] A study by Fonseca et al. (2019) found that lipid abnormalities exacerbate the progression of osteoarthritis and other joint conditions, emphasizing the importance of metabolic control.[10]
Clinical Implications and Recommendations
1. Routine Screening: Systematic evaluation of musculoskeletal symptoms and comorbidities in diabetic patients is essential for early diagnosis and intervention.
2. Integrated Management: A multidisciplinary approach targeting glycemic control, lipid optimization, and inflammation management can improve patient outcomes.
3. Patient Education: Educating patients on the importance of lifestyle changes, including exercise and weight management, can mitigate the risk of musculoskeletal complications.
4. Future Directions: Further research with larger cohorts and interventional studies is needed to explore targeted therapies addressing inflammation and glycation.

CONCLUSION

The findings of this study reinforce the high prevalence and multifactorial etiology of musculoskeletal manifestations in diabetes. Elevated inflammatory markers, poor glycemic control, and systemic comorbidities collectively contribute to the burden of these conditions. Comprehensive and integrated care strategies are essential to improving the quality of life for diabetic patients.

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