Article

Sonographic Findings in Diabetic and Non–Diabetic Obese Patients with Knee Pain

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ABSTRACT

Background: Knee pain is a prevalent musculoskeletal complaint exacerbated by metabolic and mechanical factors such as diabetes mellitus and obesity. Despite growing evidence linking diabetes to osteoarthritis, limited research has explored their combined impact on knee joint abnormalities using sonographic imaging, especially in high-risk populations. **Objective**: This study aimed to evaluate and compare sonographic findings in diabetic and non-diabetic obese patients with knee pain to identify significant structural differences and their clinical implications. **Methods**: A cross-sectional observational study was conducted on 132 obese patients (n = 66 diabetic, n = 66 non-diabetic) presenting with knee pain at the Radiology Department of Sehat Medical Complex Hospital, Lahore. Inclusion criteria were age 20–70 years, BMI >30, and knee pain history; patients with previous knee trauma, surgery, or interventions were excluded. Sonographic assessment was performed using a Toshiba AplioMx ultrasound machine with a 7–10 MHz linear transducer. Fasting blood glucose levels were used to classify diabetes status. Data were analyzed using SPSS v21 with Chi-square tests for association, and ethical approval was obtained from the University of Lahore, following the Declaration of Helsinki. **Results**: Osteoarthritis was the most common finding (45.5%), significantly more prevalent in diabetic patients (66.7%) compared to non-diabetics (33.3%) ($p = 0.001$). Gender also showed a significant association with diabetes ($p = 0.013$), with higher sonographic abnormalities in females. **Conclusion**: Diabetic obese individuals with knee pain exhibit significantly more structural joint changes, particularly osteoarthritis, highlighting the need for early musculoskeletal screening in diabetic care. Sonography offers a valuable, non-invasive tool for early detection and targeted intervention.

Keywords: Diabetes Mellitus, Obesity, Knee Osteoarthritis, Ultrasonography, Knee Joint, Sonographic Imaging, Musculoskeletal Pain

INTRODUCTION

Knee pain is increasingly recognized as a significant cause of disability and reduced quality of life across various age groups. Although often associated with aging and physical workload, recent epidemiological evidence highlights that knee pain can occur even in the absence of radiographic osteoarthritis (OA), indicating the presence of other contributing risk factors such as obesity and diabetes mellitus (1, 3). Obesity, in particular, is well-documented to exert both mechanical and metabolic stress on the knee joint, and several studies have reinforced the association between increased body mass index (BMI) and the development of knee pain and OA (9, 10, 12). Among occupational groups, workers with elevated BMI values are particularly prone to knee symptoms, suggesting that biomechanical loading is a key etiological factor

(11). However, metabolic conditions such as diabetes mellitus also independently contribute to musculoskeletal pain, altering joint structures and pain perception mechanisms (13, 14, 17).

Diabetes mellitus (DM) is a systemic disease characterized by chronic hyperglycemia resulting from defects in insulin secretion, insulin action, or both. The pathophysiological impact of DM extends to multiple organ systems including the musculoskeletal framework, where it can lead to joint stiffness, limited mobility, and increased pain severity, especially in weight-bearing joints like the knees (14, 16). Evidence suggests that individuals with type 2 diabetes mellitus (T2DM) not only report greater knee pain but also present with more widespread joint involvement compared to non-

diabetic individuals, even after controlling for confounding variables such as age and BMI (15, 17). The metabolic inflammation associated with DM may exacerbate the degenerative changes in cartilage and synovium, thereby increasing the severity and distribution of joint symptoms in OA patients (20).

Furthermore, sex-based disparities in the prevalence and severity of knee pain have been widely reported, with women generally exhibiting a higher risk of developing knee OA compared to men (8, 22). This gender-based susceptibility, when compounded by diabetes and obesity, potentially contributes to a more severe clinical picture in affected female populations. While earlier studies have attempted to delineate the independent effects of diabetes and obesity on joint health, the interplay between these factors, particularly in sonographic findings, remains underexplored. Sonography provides a non-invasive, accessible, and reliable method to evaluate intra-articular and periarticular pathologies associated with knee pain, including effusions, bursitis, osteophyte formation, and tendinopathies.

Despite a growing body of literature on the associations between diabetes, obesity, and knee OA, there is a limited focus on imaging-based assessments, especially in South Asian populations where diabetes and obesity are highly prevalent. Previous research has largely concentrated on clinical or radiographic findings, neglecting the utility of musculoskeletal ultrasound in differentiating pathological patterns in diabetic versus non-diabetic obese patients. This gap in the literature calls for studies that integrate metabolic and mechanical risk factors in the evaluation of knee pain, with sonographic imaging serving as a central diagnostic tool.

In this context, the present study aims to determine the sonographic findings in diabetic and non-diabetic obese patients presenting with knee pain. By identifying specific sonographic features and assessing their statistical associations with diabetes status and gender, the study intends to offer insights into the role of metabolic dysfunction in the pathogenesis of knee joint abnormalities. The findings are expected to enhance early diagnostic strategies and inform tailored interventions for high-risk groups. Hence, the research question guiding this investigation is: "Is there a significant association between diabetes and sonographic findings in obese patients with knee pain?"

MATERIAL AND METHODS

This study was a cross-sectional observational analysis conducted at the Radiology Department of Sehat Medical Complex Hospital, Hanjarwal, Lahore. A total of 132 participants were enrolled using convenience sampling. The sample was evenly divided into two groups: 66 diabetic obese and 66 non-diabetic obese individuals. Eligibility criteria included adults aged between 20 and 70 years with a body mass index (BMI) over 30 and a history of knee pain. Individuals were excluded if they had a history of knee trauma, surgical interventions, or any interventional procedures involving the knee joint. Participants were recruited from outpatient referrals and walk-in patients presenting with knee pain. Written informed consent was obtained from all participants prior to inclusion in the study, and all procedures were conducted in accordance with the ethical principles outlined in the Declaration

of Helsinki. The study received approval from the local ethical committee of the University of Lahore.

All participants underwent standardized clinical and diagnostic evaluations. Height and weight were measured with participants barefoot and wearing light clothing to accurately calculate BMI and waist-to-hip ratio (WHR) for assessing obesity. To classify diabetes status, venous blood samples were collected following a 12-hour overnight fast. Fasting blood glucose (FBG) levels were interpreted as follows: values between 100 and 125 mg/dL were considered prediabetic, while values exceeding 125 mg/dL were classified as diabetic. Individuals with a prior diagnosis of diabetes or those undergoing antidiabetic treatment were also classified as diabetic regardless of their FBG level (19). The primary outcome was the presence of specific sonographic findings in the knee joint, assessed using a Toshiba AplioMx ultrasound machine equipped with a linear transducer operating at a frequency of 7–10 MHz. Standard sonographic examination techniques were employed to identify intra- and periarticular abnormalities such as osteoarthritis, knee effusion, Baker's cyst, bursitis, pes anserine bursitis, tendonitis, and meniscal tears. All scans were conducted by trained radiologic technologists and reviewed by diagnostic imaging specialists.

The dataset was balanced using random sampling and the Synthetic Minority Over-sampling Technique (SMOTE) to reduce potential bias between the diabetic and non-diabetic groups. Data confidentiality was maintained throughout the study by anonymizing patient information and securely storing all data. Statistical analysis was performed using SPSS version 21. Descriptive statistics including frequencies and percentages were computed for qualitative variables such as gender, diabetes status, and individual sonographic findings. Associations between categorical variables were assessed using the Chi-square test, and a p-value of less than 0.05 was considered statistically significant.

RESULTS

A total of 132 obese patients with knee pain were included in the analysis, equally divided between diabetic (n = 66) and non-diabetic (n = 66) groups. The primary aim was to assess the association between diabetes status and sonographic findings, as well as to examine gender differences across the two groups.

The distribution of gender within diabetic and non-diabetic groups showed a statistically significant association. Among diabetic participants, 53 (80.3%) were female and 13 (19.7%) were male, whereas in the non-diabetic group, 40 (60.6%) were female and 26 (39.4%) were male. The Chi-square test revealed a significant relationship between gender and diabetes status (χ^2 = 6.15, p = 0.013), indicating that females were more frequently represented among diabetic individuals with knee pain.

Sonographic evaluation revealed multiple intra- and periarticular abnormalities among participants. The most prevalent sonographic diagnosis was osteoarthritis, detected in 60 patients (45.5%). Among these, 40 (66.7%) were diabetic and 20 (33.3%) were non-diabetic. This finding suggests a notable predominance of knee osteoarthritis in the diabetic group. Other abnormalities included Baker's cyst (n = 17), knee effusion (n = 12), bursitis (n = 10), pes anserine bursitis (n = 7), tendonitis (n = 3), and meniscal tear (n

= 2). In contrast, 21 participants exhibited normal sonographic findings, with 18 (85.7%) of these in the non-diabetic group and only 3 (14.3%) in the diabetic group. Statistical analysis demonstrated a significant association between diabetes status and sonographic findings (χ^2 = 24.86, p = 0.001). This indicates that diabetic patients exhibited a significantly greater frequency and variety of sonographic abnormalities compared to their non-diabetic counterparts.

Table 1. Cross-tabulation of gender distribution by diabetes status (N = 132)

Gender	Non-Diabetic (n = 66)	Diabetic (n = 66)	Total (n = 132)	p-value
Female	40 (60.6%)	53 (80.3%)	93 (70.5%)	0.013
Male	26 (39.4%)	13 (19.7%)	39 (29.5%)	

Table 2. Cross-tabulation of sonographic findings by diabetes status (N = 132)

Sonographic Finding	Non-Diabetic (n = 66)	Diabetic (n = 66)	Total (n = 132)	p-value
Osteoarthritis	20 (33.3%)	40 (66.7%)	60 (45.5%)	
Baker's Cyst	8 (47.1%)	9 (52.9%)	17 (12.9%)	
Knee Effusion	7 (58.3%)	5 (41.7%)	12 (9.1%)	
Bursitis	6 (60.0%)	4 (40.0%)	10 (7.6%)	
Pes Anserine Bursitis	5 (71.4%)	2 (28.6%)	7 (5.3%)	
Tendonitis	0 (0.0%)	3 (100.0%)	3 (2.3%)	
Meniscal Tear	2 (100.0%)	0 (0.0%)	2 (1.5%)	
Normal	18 (85.7%)	3 (14.3%)	21 (15.9%)	0.001

These results reinforce the hypothesis that diabetes contributes to increased prevalence of sonographic knee abnormalities, particularly osteoarthritis and soft tissue involvement. The disproportionate distribution of abnormalities in diabetic patients suggests a potentially higher burden of structural joint degeneration in this group, likely driven by chronic hyperglycemia and metabolic inflammation.
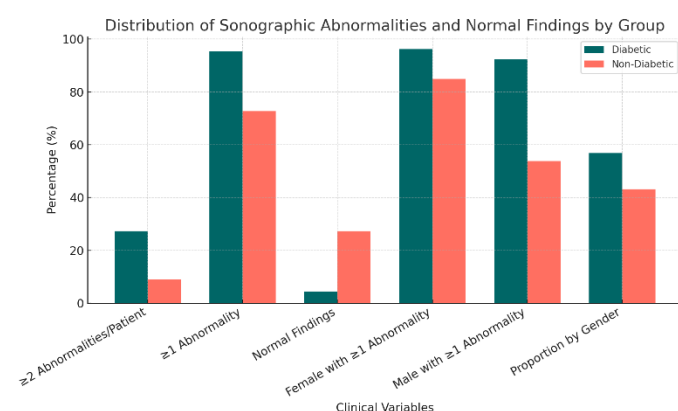

Figure 1 Distribution of Sonographic Abnormalities

Age distribution across the sample revealed that the majority of participants fell within the 31–40 age group (n = 84, 63.6%), followed by the 41–50 age group (n = 43, 32.6%). Minimal representation was seen in the 21–30 (n = 2, 1.5%) and 51–60 (n = 3, 2.3%) age groups. However, the association between age and diabetes status was not statistically significant (p = 0.376), indicating that age did not differ meaningfully between diabetic and non-diabetic groups. Collectively, the findings suggest that diabetes is significantly associated with increased sonographic abnormalities and a higher prevalence of osteoarthritis among obese patients with knee pain. These findings hold potential clinical relevance for early sonographic screening and management in diabetic populations with musculoskeletal symptoms.

DISCUSSION

The findings of this study demonstrate a significant association between diabetes mellitus and sonographic abnormalities in obese patients presenting with knee pain. In particular, osteoarthritis was markedly more prevalent in diabetic individuals, with two-thirds of the osteoarthritic cases observed in the diabetic group. These results are consistent with previous research indicating that type 2 diabetes mellitus (T2DM) is an independent predictor of both radiographic and symptomatic osteoarthritis, irrespective of age or BMI (21). The increased prevalence of sonographic changes in diabetic patients supports the hypothesis that hyperglycemia-induced systemic inflammation may contribute to accelerated joint degeneration and altered pain perception in weight-bearing joints such as the knees (20).

The current study further reinforces gender-based disparities, with female participants showing a significantly higher representation in the diabetic group and an overall greater burden of sonographic abnormalities. This observation aligns with prior reports indicating that women are disproportionately affected by knee osteoarthritis and are more likely to report pain and disability related to musculoskeletal disorders (8, 22). The biological mechanisms underlying these differences may include hormonal influences, joint alignment variability, and differential fat distribution, all of which may exacerbate joint stress and metabolic dysfunction. Furthermore, the higher prevalence of osteoarthritic changes in women with diabetes underscores the need for sex-specific approaches in musculoskeletal assessment and intervention.

Our results also complement earlier population-based studies that have linked obesity and metabolic disorders to knee pathology, particularly osteoarthritis (9, 10). While mechanical overload remains a well-established factor contributing to joint degeneration in obesity, this study emphasizes the role of diabetes as a co-contributor, possibly through mechanisms involving

advanced glycation end-products, pro-inflammatory cytokines, and microvascular compromise within joint tissues (14, 20). The lack of significant association between age and sonographic findings suggests that metabolic alterations may play a more critical role than chronological aging alone in the pathogenesis of joint degeneration among obese individuals.

Despite its contributions, this study has several limitations. The cross-sectional design precludes causal inferences, and the convenience sampling approach may introduce selection bias. The single-center nature of the study also limits generalizability, as the findings may not reflect population-level trends. Although sonographic evaluation provides a valuable, non-invasive tool for detecting soft tissue and joint abnormalities, it is operator-dependent and may vary in sensitivity compared to other imaging modalities such as MRI. Moreover, while the study accounted for fasting blood glucose and BMI, it did not control for duration of diabetes, glycemic control status (e.g., HbA1c), or comorbid conditions, which could influence musculoskeletal outcomes.

Nevertheless, the study's strengths lie in its use of standardized sonographic assessment, balanced group comparison through SMOTE-based sampling, and rigorous statistical analysis. By integrating metabolic and mechanical risk factors, it offers a nuanced understanding of knee pathology in obese populations and contributes valuable insights to the limited body of ultrasound-based evidence in this domain. These findings underscore the importance of incorporating musculoskeletal evaluation into the routine care of diabetic patients, particularly those with obesity and joint complaints.

Future research should explore longitudinal relationships between glycemic control and progression of knee joint abnormalities, ideally using multicenter, prospective cohort designs with larger and more diverse populations. Incorporating biomarkers of inflammation and metabolic dysfunction, along with advanced imaging modalities, may further elucidate the pathophysiological pathways linking diabetes and osteoarthritis. Interventional studies examining the impact of metabolic control, weight reduction, and tailored physiotherapy on sonographic outcomes could also help define optimal management strategies for this high-risk group. In clinical practice, these findings advocate for early screening and targeted musculoskeletal interventions in diabetic obese individuals, potentially mitigating progression to irreversible joint damage and disability.

CONCLUSION

This study concludes that diabetic obese patients with knee pain exhibit significantly more sonographic abnormalities, particularly knee osteoarthritis, compared to their non-diabetic counterparts. The observed association between diabetes and structural joint changes underscores the need for integrated musculoskeletal assessment in diabetic care. These findings support the utility of ultrasound as a non-invasive diagnostic tool to detect early degenerative changes in weight-bearing joints among high-risk populations. Clinically, the results highlight the importance of proactive screening and targeted interventions for joint preservation in diabetic individuals, while also suggesting future research directions focused on metabolic influences, longitudinal

disease progression, and optimized management strategies for diabetes-related musculoskeletal disorders.

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