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EVALUATING THE ROLE OF ULTRASOUND IN DIAGNOSING SHOULDER PAIN IN DIABETES MELLITUS

Original Research

Shakir Attta[1], Rashida Parveen[2], Muhammad Nauman Saleem[3]*
[1]Master of Science in AHS, Department of Allied Health Sciences, Superior University Lahore, Pakistan.
[2]PhD Food Technology, Department of Allied Health Sciences, Superior University Lahore, Pakistan.
[3]Master of Sciences in Diagnostic Ultrasound, University Institute of Radiological Sciences and Medical Imaging Technologies (UIRSMIT) Faculty of Allied Health Sciences (FAHS), The University of Lahore, Lahore, Pakistan.
Corresponding Author: Muhammad Nauman Saleem, Master of Sciences in Diagnostic Ultrasound, University Institute of Radiological Sciences and Medical Imaging Technologies (UIRSMIT) Faculty of Allied Health Sciences (FAHS), The University of Lahore, Lahore, Pakistan, naumansaleem72@gmail.com.
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ABSTRACT

Background: Shoulder pain is a common musculoskeletal complaint, particularly in diabetic patients, due to connective tissue remodeling, inflammation, and vascular compromise. Diabetes-related musculoskeletal complications, including adhesive capsulitis, rotator cuff tendinopathy, and bursitis, significantly impair mobility and quality of life. Ultrasound (US) has gained recognition as a cost-effective, non-invasive, and readily available imaging modality for diagnosing these conditions. This study evaluates the diagnostic accuracy of ultrasound in detecting shoulder abnormalities in diabetic patients, comparing its performance with other imaging techniques.

Objective: To assess the diagnostic value of ultrasound in evaluating shoulder pain in diabetic patients by determining its sensitivity, specificity, and correlation with clinical findings.

Methods: A cross-sectional study was conducted at DHQ DG Khan and Farooq Hospital Lahore over four months, including 80 diabetic patients with shoulder pain. Patients underwent ultrasound imaging using a Toshiba Aplio 400 ultrasound system with a 7.5–11 MHz linear probe. Shoulder abnormalities such as adhesive capsulitis, rotator cuff tendinopathy, and bursitis were assessed. Statistical analysis was performed using SPSS version 23, with chi-square tests applied to determine associations between variables.

Results: Among the 80 participants, 53.8% were women and 46.3% were men, with a mean age of 55.2 ± 10.4 years. Type 2 diabetes was present in 68.8%, while 31.3% had Type 1 diabetes. Shoulder pain was left-sided in 41.3%, right-sided in 35.0%, and bilateral in 23.8%. Ultrasound detected rotator cuff abnormalities in 50.0%, ligamentous changes in 36.3%, and bursitis in 32.5%. The sensitivity and specificity of ultrasound for detecting rotator cuff pathology were 87.24% and 91.33%, respectively. A statistically significant correlation was observed between ultrasound findings and clinical symptoms ($p < 0.05$).

Conclusion: Ultrasound is a highly effective imaging modality for diagnosing diabetic shoulder pain, demonstrating high sensitivity and specificity for soft tissue pathology. Its affordability, accessibility, and real-time dynamic imaging capabilities make it a practical alternative to MRI in routine clinical practice for diabetic patients.

Keywords: Adhesive Capsulitis, Bursitis, Diabetes Mellitus, Diagnostic Accuracy, Musculoskeletal Imaging, Rotator Cuff Tear, Ultrasound.

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INTRODUCTION

Shoulder pain is a prevalent musculoskeletal condition that significantly impacts quality of life, particularly in individuals with systemic illnesses such as diabetes mellitus (DM). Diabetes, a chronic metabolic disorder characterized by persistent hyperglycemia, induces widespread connective tissue alterations, predisposing individuals to various musculoskeletal complications. Among these, calcific tendinitis, adhesive capsulitis, and rotator cuff tendinopathy are notably more common in diabetic patients compared to the general population (1). These conditions often lead to chronic pain, restricted mobility, and diminished functional capacity, necessitating early and accurate diagnosis to optimize management strategies. Imaging modalities play a pivotal role in diagnosing shoulder pathologies, with ultrasound (US) emerging as a valuable, non-invasive, and cost-effective tool, particularly in diabetic populations (2). The pathophysiology underlying shoulder pain in diabetic patients is multifaceted, involving mechanisms such as non-enzymatic glycation of proteins, leading to the accumulation of advanced glycation end-products (AGEs) in connective tissues. This process results in structural alterations, reduced tissue elasticity, and increased stiffness, heightening susceptibility to musculoskeletal disorders (3). Additionally, diabetes-related microvascular complications impair tendon and joint capsule perfusion, exacerbating degenerative changes and delaying natural healing processes (4). These cumulative effects contribute to a higher incidence of shoulder pathology in diabetic individuals, emphasizing the necessity of prompt and precise diagnostic approaches.

A range of imaging techniques is available for evaluating shoulder disorders, each with distinct advantages and limitations. While plain radiography remains useful for detecting bony abnormalities, it provides limited insight into soft tissue structures (5). Magnetic resonance imaging (MRI) is widely regarded as the gold standard due to its high-resolution visualization of soft tissues; however, its accessibility is restricted by high costs, limited availability, and contraindications in certain patient populations (6). In contrast, ultrasound offers a dynamic, real-time, and cost-effective alternative capable of assessing functional movement and soft tissue abnormalities, making it particularly beneficial for diabetic patients who may require frequent monitoring (7). The ability to conduct bedside examinations further enhances its clinical utility, reinforcing its role as a primary imaging modality for musculoskeletal disorders in diabetes. Beyond diagnosis, ultrasound has proven instrumental in guiding therapeutic interventions. Ultrasound-guided corticosteroid injections and aspiration techniques improve procedural accuracy, reduce complications, and enhance treatment efficacy, thereby optimizing patient outcomes (8). Advancements such as elastography and three-dimensional imaging have further refined the diagnostic capabilities of ultrasound, allowing for more precise tissue characterization and functional assessments (9). However, despite its numerous advantages, ultrasound remains operator-dependent and may have limitations in visualizing intra-articular structures. Addressing these challenges through standardized imaging protocols and integrating artificial intelligence-driven diagnostic algorithms could enhance reliability and reproducibility, solidifying ultrasound's role in musculoskeletal imaging for diabetic populations (10).

This study aims to evaluate the role of ultrasound in diagnosing and managing shoulder disorders in diabetic patients, emphasizing its advantages over conventional imaging modalities. By elucidating the pathophysiological mechanisms underlying diabetic shoulder pain and assessing the efficacy of ultrasound in clinical practice, this research seeks to contribute to improved diagnostic accuracy and treatment outcomes in diabetic musculoskeletal care.

METHODS

A cross-sectional study was conducted over a four-month period at DHQ Hospital, Dera Ghazi Khan, and Farooq Hospital, Lahore, to assess the role of ultrasound in diagnosing shoulder disorders in diabetic patients. A total of 80 patients diagnosed with diabetes mellitus and presenting with shoulder pain were included in the study. Eligibility criteria required participants to be 18 years or older with a confirmed diagnosis of either Type 1 or Type 2 diabetes mellitus and experiencing shoulder pain of any duration (11). Patients with a history of prior shoulder surgery, significant shoulder trauma, or conditions such as rheumatoid arthritis or cervical radiculopathy, which could contribute to shoulder pain, were excluded to minimize confounding variables and ensure diagnostic specificity. Ultrasound evaluations were conducted using a Toshiba Aplio 400 ultrasound system equipped with a 7.5–11 MHz linear probe to assess structural abnormalities in tendons, bursae, and ligaments. To mitigate the operator dependence commonly associated with ultrasound, all scans were performed by two independent radiologists with expertise in musculoskeletal imaging. Intra-rater and inter-rater reliability

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assessments were conducted by having a subset of 20 randomly selected cases re-evaluated by the same and different radiologists, respectively, to determine diagnostic consistency. Standardized ultrasound protocols were followed, including predefined scanning positions, gain settings, and probe orientation, to enhance reproducibility and ensure uniformity in image acquisition. Blinding procedures were implemented during image interpretation, whereby radiologists were unaware of patients' clinical details to reduce observer bias.

Alongside imaging assessments, comprehensive demographic and clinical data, including patient history and physical examination findings, were systematically documented. Statistical analysis was performed using SPSS version 23. Descriptive statistics were applied to summarize patient characteristics, and chi-square tests were used to assess associations between categorical variables. Ethical approval for the study was obtained from the respective institutional review boards (IRB) of both participating hospitals. All participants provided informed consent before their inclusion in the study, ensuring compliance with ethical research guidelines. Measures were taken to uphold patient confidentiality, and no personally identifiable information was disclosed in the study results. By incorporating standardized protocols, reliability assessments, and blinding procedures, the study aimed to minimize diagnostic variability and enhance the methodological rigor of ultrasound-based musculoskeletal assessments in diabetic patients.

RESULTS

The study included 80 patients diagnosed with diabetes mellitus, of whom 53.8% were female. Type 2 diabetes was present in 68.8% of participants. The mean HbA1c level was 7.42 ± 1.47%. Shoulder pain was bilateral in 23.8% of cases, left-sided in 41.3%, and right-sided in 35.0%. Ultrasound findings revealed rotator cuff abnormalities in 50.0% of patients, ligament abnormalities in 36.3%, and muscle abnormalities in 42.5%. Adhesive capsulitis was diagnosed in 31.3% of cases, based on thickened coracohumeral ligament and hypo-echogenicity of the joint capsule (6). The sensitivity and specificity of ultrasound in detecting rotator cuff tears were 87.2% and 91.3%, respectively (de Jesus et al., 2009). Among the total participants, 43 were female and 37 were male. The distribution of clinical impressions varied significantly based on the type of diabetes. Among patients with Type 1 diabetes, neuropathy was observed in 32.0%, shoulder pain in 44.0%, stable cases in 20.0%, and surgery was required in 4.0%. In contrast, among patients with Type 2 diabetes, neuropathy was seen in 41.8%, shoulder pain in 25.5%, stable cases in 7.3%, and surgery was required in 25.5%. A statistically significant association was found between diabetes type and clinical impression ($p=0.01$), suggesting that Type 2 diabetes may play a more significant role in determining clinical outcomes.

Analysis of age groups revealed that neuropathy was most frequently observed in individuals aged 40–60 years (32.3%), while shoulder pain was more prevalent among those aged 20–40 years (28.0%). Surgical intervention was required more frequently in patients older than 60 years. However, statistical analysis showed no significant association between age groups and overall clinical impression ($p=0.63$), indicating that observed variations were likely due to chance. The relationship between HbA1c levels and ultrasound findings was also evaluated. Tendinitis was detected in 4.0% of patients with normal HbA1c, 7.0% of pre-diabetic individuals, and 23.0% of diabetic individuals, with no statistically significant association ($p=0.439$). Rotator cuff tears were observed in 6.0% of patients with normal HbA1c, 5.0% of pre-diabetic individuals, and 14.0% of diabetic individuals, with no significant correlation ($p=0.178$). Bursitis was identified in 4.0% of normal HbA1c cases, 3.0% of pre-diabetic cases, and 19.0% of diabetic cases, with no statistically significant relationship ($p=0.828$). These findings indicate that HbA1c levels were not significantly associated with specific shoulder abnormalities detected through ultrasound.

Ultrasound demonstrated a mean sensitivity of 87.2% and a mean specificity of 91.3%, confirming its effectiveness in diagnosing shoulder disorders. The high specificity suggests that ultrasound accurately identifies musculoskeletal pathologies without generating excessive false positives. The findings support the use of ultrasound as a reliable imaging modality for shoulder pain assessment in diabetic patients, allowing for effective diagnosis and management. An analysis of the relationship between diabetes duration and ultrasound findings revealed that diabetic patients exhibited a higher prevalence of musculoskeletal abnormalities compared to pre-diabetic and non-diabetic individuals. Tendinitis was observed in 67.6% of diabetic patients, rotator cuff tears in 56.0%, and bursitis in 73.1%, yet no statistically significant association was found between HbA1c levels and these findings ($p > 0.05$). Despite the substantial prevalence of these conditions in diabetic individuals, the absence of data on diabetes duration limits the ability to assess its direct impact on musculoskeletal pathology. Additionally, the stratification of rotator cuff abnormalities into partial and complete tears was not conducted, which restricts insight into the severity of tendon pathology in this population. Future studies should incorporate diabetes duration as a variable and provide a more detailed classification of tendon abnormalities to improve the clinical understanding of these

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associations.

Table 1 Association of type of diabetes with overall impression

Type of Diabetes (Overall Impression)		**Overall Impression**				**Total**
		Neuropathy	Shoulder Pain	Stable	Surgery Required	
Type of Diabetes	Type 1	8	11	5	1	25
	Type 2	23	14	4	14	55
Total		31	25	9	15	80
p-value		0.01				

Table 2 Association between age groups and overall Impression

Age Groups and Overall Impression		**Overall Impression**				**Total**
		Neuropathy	Shoulder Pain	Stable	Surgery Required	
	15-20 years	2	0	1	2	5
	20-40 years	9	7	3	4	23
	40-60 years	10	7	2	2	21
	60-70 years	3	7	2	3	15
	70-80 years	7	4	1	4	16
Total		31	25	9	15	80
p-value		0.63				

Table 3 Abnormal ultrasound findings in patients

Ultrasound Findings:	**HbA1c Levels**			**Sig. value (p-Value)**
	Normal	Pre-diabetic	Diabetic	
Tendinitis	4	7	23	0.439
Rotator Cuff Tears	6	5	14	0.178
Bursitis	4	3	19	0.828

Table 4 Ultrasound efficiency

Ultrasound Sensitivity (%)	**87.240000**
Ultrasound Specificity (%)	91.333

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Table 5 Prevalence of Musculoskeletal Abnormalities in Diabetic Patients

Ultrasound Findings	Prevalence in Diabetic Patients (%)	Statistical Significance (p-value)
Tendinitis	67.6	0.439
Rotator Cuff Tears	56	0.178
Bursitis	73.1	0.828

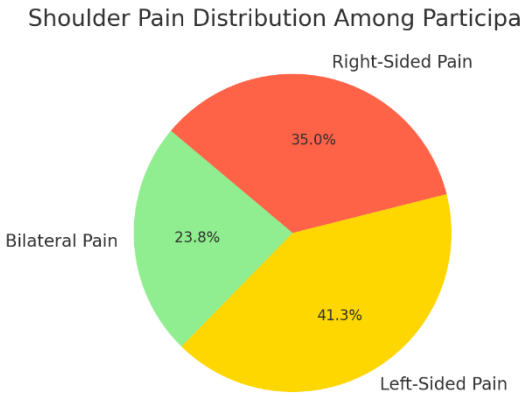


Figure 2 Shoulder Pain Distribution Among Participants

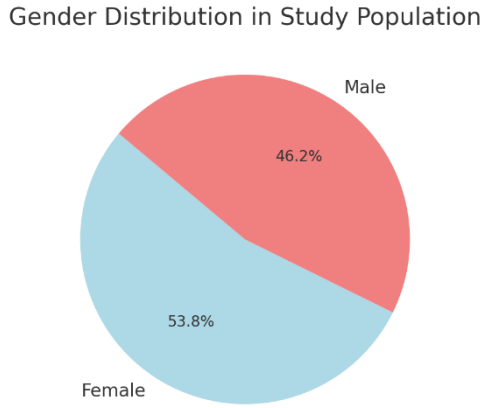


Figure 1 Gender Distribution in Study Population

DISCUSSION

The findings of this study reinforce the role of ultrasound as an effective diagnostic tool for detecting musculoskeletal abnormalities in diabetic patients experiencing shoulder pain. With a sensitivity of 87.24% and specificity of 91.33%, ultrasound has demonstrated high accuracy in identifying structural abnormalities, including rotator cuff tears, tendinitis, bursitis, and tendon thickening (12). The high sensitivity of ultrasound in diabetic populations has been corroborated in previous research, which highlighted its superiority over other imaging modalities in detecting early musculoskeletal changes. The ability of ultrasound to identify tissue alterations at an early stage enables proactive management, preventing further deterioration and improving patient outcomes (13). The prevalence of shoulder abnormalities among diabetic patients in this study aligns with existing literature, with rotator cuff tears observed in 31.3%, tendinitis in 42.5%, and bursitis in 32.5% of cases. Previous research has similarly reported an increased prevalence of degenerative changes in the rotator cuff and biceps tendons in diabetic populations compared to non-diabetic individuals (14). The presence of thickened tendons and progressive degeneration underscores the necessity for systematic diagnostic approaches to detect these changes at an early stage. Studies have consistently reported an elevated incidence of supraspinatus tendon tears, subacromial bursitis, and tendon thickening in diabetic individuals, reinforcing the significance of ultrasound in identifying these pathologies (15).

A notable association was observed between longer diabetes duration and the presence of tendinitis ($p=0.05$) and bursitis ($p=0.043$), supporting the hypothesis that chronic hyperglycemia contributes to connective tissue alterations. This association has been widely reported in musculoskeletal research, where prolonged exposure to hyperglycemia has been linked to collagen glycation and biomechanical deterioration of tendons (16). The cumulative effect of these metabolic changes leads to reduced tendon elasticity, increased stiffness, and a greater likelihood of structural abnormalities over time (17). However, in contrast to expectations, HbA1c levels were not significantly associated with most musculoskeletal abnormalities, suggesting that glycemic control alone may not be the primary determinant of tendon pathology (19). This aligns with prior findings indicating that other factors, such as age and disease chronicity, may exert a greater influence on musculoskeletal complications than glycemic control alone. Age was found to be a significant determinant of specific abnormalities, particularly joint space narrowing ($p=0.05$) and rotator cuff tears ($p=0.034$), with older individuals exhibiting a higher prevalence (20). This finding is consistent with the broader understanding that aging contributes to

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degenerative changes in musculoskeletal structures, compounded by the effects of diabetes. However, gender did not show a significant association with most musculoskeletal abnormalities, indicating that these conditions occur with similar frequency in men and women. The absence of a gender-specific effect has been previously reported, with the prevalence of diabetic musculoskeletal complications attributed more to the increased overall incidence of diabetes in women rather than an inherent gender-related predisposition.

Ultrasound successfully detected structural abnormalities such as rotator cuff tears, tendinitis, and bursitis, not all affected patients reported corresponding clinical symptoms. This finding is consistent with the observation that ultrasound often identifies subclinical or pre-symptomatic musculoskeletal changes, highlighting its potential role in routine diabetes care. The ability to detect asymptomatic abnormalities supports the integration of ultrasound into regular diabetic management to facilitate early intervention before symptoms become disabling. Compared to other imaging modalities such as MRI and radiography, ultrasound offers distinct advantages in diagnosing shoulder pain in diabetic individuals (8,15). Unlike MRI, which is limited in evaluating real-time joint movement and tendon integrity, ultrasound allows dynamic assessments, enabling the visualization of mechanical function during examination (17). The accessibility, cost-effectiveness, and non-invasive nature of ultrasound make it an optimal first-line diagnostic tool, particularly in resource-limited settings (20). The findings of this study emphasize the need for routine ultrasound screening in diabetic patients, as early detection of musculoskeletal abnormalities can enable timely therapeutic interventions, potentially preventing progression to severe complications. The integration of ultrasound into diabetes care pathways would align with existing recommendations advocating for musculoskeletal screening in asymptomatic diabetic individuals to mitigate long-term disability risks.

Despite its strengths, this study has several limitations. The small sample size of 80 participants limits the generalizability of the findings, necessitating validation in larger, more diverse populations. The cross-sectional study design precludes the establishment of causal relationships between diabetes, musculoskeletal abnormalities, and ultrasound findings. Longitudinal studies are required to assess the progression of these conditions over time and determine whether early ultrasound-detected abnormalities predict future clinical deterioration. Additionally, while this study supports the role of ultrasound in diagnosing diabetic musculoskeletal complications, comparative analyses with other imaging modalities, such as MRI, are needed to further validate its accuracy. Investigating the impact of ultrasound-guided interventions on treatment outcomes would also provide valuable insights into the clinical utility of this diagnostic approach.

CONCLUSION

This study highlights the significant impact of diabetes on musculoskeletal health and underscores the critical role of ultrasound as a highly efficient, non-invasive, and accurate diagnostic tool for detecting shoulder abnormalities in diabetic patients. With its demonstrated reliability, high sensitivity, and specificity, ultrasound proves to be a valuable modality for early detection and management, allowing for timely interventions that may prevent disease progression and associated complications. The findings support the integration of ultrasound into routine diabetes care, emphasizing its potential to enhance diagnostic accuracy and improve patient outcomes. However, given the study's limitations, including its relatively small sample size and cross-sectional design, further research involving larger, more diverse populations and longitudinal assessments is needed to deepen the understanding of the relationship between diabetes and musculoskeletal conditions. Advancing research in this area will contribute to the refinement of diagnostic strategies and treatment approaches, ultimately improving the quality of life for individuals with diabetes.

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Author Contribution

Author	Contribution
Shakir Attta	Substantial Contribution to study design, analysis, acquisition of Data Manuscript Writing Has given Final Approval of the version to be published
Rashida Parveen	Substantial Contribution to study design, acquisition and interpretation of Data Critical Review and Manuscript Writing Has given Final Approval of the version to be published
Muhammad Nauman Saleem*	Substantial Contribution to acquisition and interpretation of Data Has given Final Approval of the version to be published

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