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Association Between Frozen Shoulder and Diabetes Mellitus: A Narrative Review

Tarek H. Mahmoud[1], Mohamed Salah El-Sayed[2,3] and Wael Gomaa[4]

* [1] Lecturer of Physical Therapy, Department of Physical Therapy for Internal Medicine, Chest and Cardiology, Faculty of Physical Therapy, Deraya University, Minia, Egypt.
[2] Assistant Professor, Physiotherapy Department, Faculty of Allied Medical Sciences, Al-Ahliyya Amman University, Jordan.
[3] Lecturer, Department of Physical Therapy for Pediatrics, Faculty of Physical Therapy, Horus University-Egypt, New Damietta, Egypt.
[4]Demonstrator of Physical Therapy, Department of Basic Since, Faculty of Physical Therapy, Deraya University, Minia, Egypt.

Abstract

Background: Diabetes mellitus (DM) significantly impacts joint function, particularly affecting the shoulder, which plays a crucial role in mobility and daily activities. Frozen shoulder (FS) is notably more prevalent in individuals with diabetes, affecting approximately 10%–38% of diabetic patients, compared to 2%–5% in the general population. This highlights a strong correlation between diabetes and FS.
Objective: This review seeks to offer a contemporary viewpoint on the correlation between diabetes and frozen shoulder.
Methods: A systematic search was conducted using Google Scholar, Science Direct, PubMed, and Consensus databases with keywords including "diabetes mellitus," "frozen shoulder," and "adhesive capsulitis." The review includes studies published between January 2010 and January 2025, focusing on both Type 1 and Type 2 diabetes. Non-peer-reviewed studies, conference abstracts, and case reports were excluded.
Results: Several factors have been found to have a role in the development of tendon alterations and increased capsular stiffness, which can result in restricted shoulder mobility. These factors include age, duration of diabetes, glycated hemoglobin (HbA1c), advanced glycation end products (AGEs), vascular endothelial growth factor (VEGF), and interleukin-1ß (IL-1ß). Frozen shoulder is far more common in diabetes people, according to the research.
Conclusion: There is substantial evidence in the current literature linking diabetes to frozen shoulder. The exact mechanisms remain unclear, necessitating further research to explore the multifactorial nature of this condition. While manual therapy and exercise-based physiotherapy remain standard treatment approaches, limited research exists on tailored physiotherapy protocols based on tissue irritability levels.
Key words: Diabetes; diabetes mellitus; frozen shoulder; adhesive capsulitis

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Introduction:

Frozen shoulder, or adhesive capsulitis, is a musculoskeletal condition marked by discomfort and a progressive decline in both active and passive shoulder mobility. It impacts between 2-5% of the general populace, with a heightened prevalence of 10-38% in those with diabetes or thyroid conditions[1]. This condition typically impacts people aged 40 to 60 years, with a greater frequency observed in women. Frozen shoulder develops gradually and progresses through three phases: freezing, frozen, and thawing, which can span several months to years[2]. The condition usually begins between the ages of 40 and 70, with rare instances of onset before 40[3]. Women account for 58% of those affected, and 6%-17% of patients may experience frozen shoulder in the opposite shoulder as well[4]. Pathophysiology of frozen shoulder (adhesive capsulitis) involves inflammation and fibrosis of the joint capsule and surrounding tissues of the glenohumeral joint[5]. This condition is characterized by progressive stiffness and pain, leading to severe limitations in both active and passive shoulder movements[6]. A key clinical feature of frozen shoulder is the pronounced restriction of external rotation. Although often described as a self-limiting disorder that resolves without intervention, substantial evidence indicates that many patients experience persistent pain and long-term functional impairment.

Conservative management is the first-line treatment for frozen shoulder and typically includes analgesics, corticosteroid injections, and physiotherapy involving gentle mobilization and exercises. In instances when symptoms are resistant to non-surgical treatments, more invasive options such manipulation under anesthesia, arthroscopic capsular release, or hydrodilatation may be contemplated. At now, there is no widely recognized treatment regimen for frozen shoulder, as clinical results differ across individuals[7]. Diabetes mellitus (DM) is a chronic metabolic condition marked by hyperglycemia, with Type 1 and Type 2 diabetes representing around 8% and 90% of cases, respectively[8].
In Egypt, the prevalence of diabetes among adults is reported to be 18.4%[9]. While diabetes is widely recognized for its complications affecting the cardiovascular system, kidneys, nerves, and eyes[4], its impact on the musculoskeletal system is less well known[10]. Frozen shoulder is a prevalent musculoskeletal consequence of diabetes, with diabetic persons being five times more susceptible to the illness than non-diabetics. Research estimates the incidence of frozen shoulder among diabetes individuals to be around 13.4%[11], with diabetic individuals comprising approximately 30% of all frozen shoulder cases[11]. The exact mechanism linking diabetes and frozen shoulder remains uncertain, but it is hypothesized that glycation processes contribute to structural changes in the joint capsule, leading to stiffness and restricted movement[12]. Among diabetic patients, frozen shoulder is the most frequently reported shoulder disorder[13,14]. Although the precise etiology of adhesive capsulitis remains unclear, proposed mechanisms include the accumulation of irreversible crosslinks between adjacent protein molecules, vascular and neural damage, and excessive collagen deposition in connective tissues[13]. Research based on animal models has demonstrated that diabetes is associated with increased tendon diameter and stiffness, supporting the hypothesis that chronic hyperglycemia influences connective tissue changes[15]. The primary pathological mechanism contributing to tendon dysfunction in diabetes is inflammation. Pro-inflammatory cytokines such as tumor necrosis factor-alpha (TNF-α) and interleukin-6 (IL-6) are persistently elevated in diabetic individuals, triggering a cascade of inflammatory responses that result in chronic inflammation, excessive collagen buildup, and fibrosis[16,17]. This progressive connective tissue stiffness, attributed to the structural reorganization of collagen fibers, is closely associated with the formation of advanced glycation end products (AGEs), which are thought to play a critical role in the pathogenesis of adhesive capsulitis[18-20].

2. Materials and Methods:

A thorough database search was performed utilizing keywords like "diabetes mellitus," "diabetes," "adhesive capsulitis," "frozen shoulder," "physiotherapy for frozen shoulder," "rehabilitation," "protocol," "physiotherapy," and "physical therapy." The search encompassed just English-language research published from January 2010 to January 2025, without limitations on publication genre. Research with inadequate material or not indexed in PubMed was eliminated. Thirty-eight pertinent papers examining the correlation between diabetic mellitus (DM) and the incidence of adhesive capsulitis (AC) were discovered. This narrative review examines Type 1 Diabetes Mellitus (T1DM), blood glucose levels, duration of diabetes, and the underlying pathophysiology of adhesive capsulitis.

3. Prevalence of Frozen Shoulder and Diabetes:

3.1. Prevalence of FS in DM Patients:

Diabetes mellitus (DM) is a significant risk factor for frozen shoulder (FS). The overall prevalence of FS in the general population ranges from 2% to 5%[21]. Studies have identified associations between FS and factors such as gender, family history, glycated hemoglobin (HbA1c) levels, and the duration of diabetes. However, no significant correlation has been found between FS and age, diabetes type, or mode of medication. In this study, the prevalence of FS among diabetic patients was reported as 54.78%, the highest rate documented to date. However, different studies have reported varying prevalence rates of FS in diabetic populations[22].A meta-analysis conducted by Zreik, which included thirteen studies published before 2014, estimated the prevalence of FS among diabetic patients to be approximately 13.4%, indicating that individuals with DM are at nearly five times higher risk of developing FS compared to non-diabetics[23]. Given the strong correlation between FS and DM, another critical question arises: What is the incidence of diabetes mellitus among patients diagnosed with fibromyalgia syndrome? A high prevalence may facilitate the early identification of diabetes mellitus. Nonetheless, investigations in this domain remain constrained. A review by Zreik, examining five papers published prior to 2014, determined that the incidence of diabetes mellitus among fibromyalgia syndrome patients varied from 20% to 40%, with a mean frequency of 30%[23].
Numerous studies have provided evidence supporting the association between diabetes mellitus (DM) and frozen shoulder (FS). This includes two cross-sectional studies[24,25], three retrospective studies[26-28], and two prospective studies[29,30] (Table 1). Most research published since 2015 continues to reinforce this association. A comprehensive study by Dyer confirmed earlier data, indicating that patients with diabetes mellitus have a 3.69-fold increased chance of experiencing frozen shoulder compared to non-diabetic individuals[31]. Research by Inayat indicated an FS prevalence of roughly 41.3% among diabetic individuals[32]. Moreover, Kim's extensive study, which examined data from 3.47 million individuals utilizing a health insurance database, corroborated the association between diabetes mellitus and an elevated incidence of adhesive capsulitis. Jacob's study, however, revealed no statistically significant correlation between DM and FS[28]. He suggested that FS risk is more pronounced in individuals with severe DM, implying that variations in study outcomes may be attributed to differences in sample size and the inclusion of patients with milder forms of diabetes. Severe DM in this context refers to prolonged disease duration or persistently high blood sugar levels, a topic that will be further explored in the following sections.

Table 1. studies shown the prevalence of FS in DM patients and the prevalence of DM in FS patients.

Study	DM Types	Methods	Results
Shahid et al (2017)[33]	Not Specified	80 patients with diabetes. A cross-sectional study	(1) Patients with insulin-dependent diabetes have **a** 1.93 times higher likelihood of developing adhesive capsulitis (AC), which increases to 1.96 times after adjusting for HbA1c levels. (2) Individuals using oral hypoglycemic agents are 1.5 times more likely to develop AC compared to those not receiving insulin or oral medications. (3) Insulin users, regardless of whether they also take oral hypoglycemic agents, have a 1.2 times higher risk of AC. (4) Poor glycemic control over the past three months is associated with a 1.5 times increased risk of AC. (5) Overall, 41.3% of diabetic patients were found to have AC.
El-Haj et L (2017)[25]	Not Specified	50 patients with AC. A cross-sectional study.	(1) Prediabetes was identified in 8% of patients diagnosed with adhesive capsulitis (AC). (2) No cases of diabetes mellitus (DM) were observed among patients with AC.
Attrup et al (2018)[27]	Not Specified	34 patients with and 201 patients without diabetes. A retrospective study.	(1) No significant difference was observed in the prevalence of adhesive capsulitis (AC) between diabetic patients and the control group **(**0% vs. 2.6%**).**
Alhashimi et al. (2018)[29]	Not Specified	216 patients with DM. A prospective study.	(1) Diabetes mellitus (DM) was present in 90.3% of patients diagnosed with adhesive capsulitis (AC). (2) Frozen shoulder (FS) is frequently observed in chronic DM, with a prevalence of 32.3% in patients with diabetes for 1–5 years and 33.8% in those with diabetes for 5–10 years**.** (3) Between 10% and 30% of diabetic patients develop AC, and they often exhibit a reduced response to treatment**.**
Kashid et al (2019)[30]	Not Specified	135 patients with AC. A prospective study.	(1) Prediabetes was identified in 15.5% of patients with adhesive capsulitis (AC). (2) Diabetes mellitus (DM) was present in 27.4% of AC patients.

Han et al (2023)[26]	T2DM	3,471,745 subjects with type 2 DM in NHIS medical checkup. A retrospective study.	(1) Incidence rates (IR) of adhesive capsulitis (AC): • Normal group: 9.453 • Prediabetes group: 11.912 • Newly diagnosed Type 2 diabetes mellitus (new-T2DM) group: 14.933 • T2DM group (with a history of antidiabetic medication use): 24.376 (2) Adjusted incidence rates (IR) of AC: • Normal group: 1 (reference) • Prediabetes group: 1.084 • New-T2DM group: 1.312 • T2DM group: 1.473 (Newly diagnosed Type 2 diabetes mellitus (new-T2DM) refers to individuals without a prior claim history for antidiabetic medication use, whereas the T2DM group includes those with a recorded history of antidiabetic treatment.)
Gyasi et al (2023)[28]	Not Specified	8439 patients with and 42,195 patients without AC. A retrospective study.	(1**)** Diabetes mellitus (DM) was present in 36.5% **of** patients with adhesive capsulitis (AC), compared **to** 33.9% in the normal population**.** (2) No significant association was found between DM and AC.
Murali et al (2024)[34]	Not Specified	158 patients with primary AC. A prospective study.	(1) Prediabetes was identified in 37.3% of patients with adhesive capsulitis (AC). (2) Diabetes mellitus (DM) was present in 46.2% of AC patients.

3.2. Prevalence of DM in FS Patients:

Zreik's analysis of five studies prior to 2014 indicated that the prevalence of diabetes mellitus (DM) in individuals with adhesive capsulitis (AC) varied between 20% and 40%, with a mean frequency of 30%[23]. Despite the limitations of small sample sizes and outdated data, if the conclusions are valid, they may endorse the utilization of AC as a possible marker for diabetes screening. Recent research, however, have shown contradictory findings on this subject (Table 1). El-Haj and Safran discovered that, among 50 AC patients, only four were classified as prediabetic, with none diagnosed with DM[25]. A comparable discovery was documented by Attrup[27]. In contrast, Kashid's study revealed that, out of 135 AC patients, 21 were diagnosed with prediabetes and 37 with diabetes mellitus[30]. Similarly, Murali's research on 158 AC patients found that 59 had prediabetes and 73 were diagnosed with DM[34]. These investigations have indicated considerable discrepancies in the prevalence of prediabetes (from 8% to 15.5% to 37.3%) and diabetes mellitus (from 0% to 27.4% to 46.2%), rendering the association between AC and diabetes mellitus very debatable. Furthermore, Alhashimi's study demonstrated that AC is more frequently observed in individuals with chronic DM, with prevalence rates of 32.3% in those with diabetes for 1–5 years and 33.8% in those with diabetes for 5–10 years[29]. These findings align with those of Yian and Juel, who identified a longer DM duration as a significant risk factor for AC[27,35]. While screening AC patients for DM may help identify undiagnosed cases of chronic diabetes, its role in early DM detection remains uncertain.

4. Diagnosis and management:

The diagnosis of frozen shoulder (FS), in both primary and secondary care contexts, relies predominantly on clinical assessment and patient history. A hallmark feature indicative of FS is restricted shoulder movement in all planes,

affecting both active and passive ranges of motion[36]. Laboratory tests, radiographic imaging, and ultrasound findings are typically unremarkable and are not routinely necessary unless the clinical assessment suggests an alternative diagnosis, such as rheumatoid arthritis or osteoarthritis. FS is primarily overseen in primary care settings. UK research analyzing referral and diagnostic patterns in shoulder disorders indicated that 22% of patients were sent to secondary care, typically within three months after initial presentation, while some referrals were postponed for as long as three years[37]. However, specific data on referral patterns for FS remain limited[38]. Numerous therapy modalities are available for the management of frozen shoulder (FS), encompassing both surgical and non-surgical interventions; nevertheless, a definitive consensus on the most efficacious method remains elusive. In this evaluation, treatment options are classified into conservative and invasive measures (Table 2). The principal objectives of treatment, contingent upon the condition's stage, encompass alleviation of pain, enhancement of shoulder mobility, diminution of symptom duration, and reinstatement of normal functional activities.

Conservative Management Approaches:

- **Watchful waiting or "supervised neglect":** This approach involves educating the patient about the condition, providing guidance on pain-limited mobilization, and advising on appropriate pain relief methods.
- **Pharmacological treatment:** non-steroidal anti-inflammatory drugs (NSAIDs) and oral corticosteroids are occasionally used for symptom relief. Although oral steroids are mentioned in the literature, their use is not widespread in the UK.
- **Exercise therapy:** Gentle, structured exercises, either under the supervision of a physiotherapist or as part of a home-based program, aim to restore mobility and prevent stiffness.
- **Physical therapy techniques:** These interventions focus on regaining range of motion and preventing further restriction. Numerous physiotherapeutic techniques have been documented in the literature, encompassing guided exercises, manual mobilization, and electrotherapeutic modalities. Mobilization entails therapist-directed passive joint motions, maintaining patient control consistently.

Electrotherapy Modalities:

- **Transcutaneous electrical nerve stimulation (TENS) and interferential therapy:** These techniques use electrical pulses to provide analgesic effects.
- **Short-wave diathermy (SWD) and pulsed short-wave diathermy (PSWD):** These modalities apply radiofrequency energy to generate heat in deep tissues, helping to reduce muscle spasms and joint stiffness.
- **Ultrasound therapy:** High-frequency mechanical vibrations generate heat, promoting tissue relaxation and improving circulation to the affected area.

TABLE 2 Classification of interventions for frozen shoulder:

Conservative treatment	Steroid injections
	Physical therapy
	Acupuncture
Invasive treatment	Sodium hyaluronate
	MUA
	Distension
	Capsular release

Ultrasound treatment elicits a comparable therapeutic effect to short-wave diathermy (SWD) and pulsed short-wave diathermy (PSWD) by creating heat, hence alleviating stiffness and pain[39]. Conversely, low-level laser treatment (LLLT) is a non-thermal modality believed to alleviate pain and inflammation, although its exact mechanism of action is not well understood[40].

Other complementary therapies have also been explored for managing frozen shoulder. Acupuncture, a traditional Chinese medicine practice, involves inserting fine needles at specific points on the body to promote pain relief. Chiropractic care primarily focuses on manual therapies, particularly spinal manipulation, while osteopathy employs gentle stretching, massage, and manipulation techniques targeting muscles and joints[41].

Invasive Treatment Options for Frozen Shoulder

Several invasive interventions are available for managing frozen shoulder (FS), though there is no standardized consensus on their optimal sequence or application. These interventions include:

- **Intra-articular corticosteroid injections:** These injections help reduce inflammation and provide pain relief. Various dosages and regimens have been described in the literature. This treatment is typically administered in primary care settings but can also be provided in secondary care, depending on local healthcare service organization.
- **Arthrographic distension (hydrodilatation):** This procedure involves the controlled expansion of the joint capsule using sterile saline, local anesthetic, or corticosteroids under radiological guidance (arthrography). It is performed under local anesthesia.
- **Manipulation under anesthesia (MUA):** The shoulder joint is mobilized through controlled rotation while the patient is under short-duration general anesthesia. This is commonly performed as a day procedure.

- **Arthroscopic capsular release:** A minimally invasive surgical procedure performed under general or regional anesthesia, during which contracted tissue is released to restore mobility. In cases resistant to arthroscopic intervention, open capsular release may be recommended. Both procedures can be performed on an outpatient basis.

These interventions may be used alone or in combination, depending on the stage and severity of the condition. However, there remains no clear consensus on the best treatment approach or the ideal sequence of interventions. A recent survey of 303 UK healthcare professionals—including general practitioners (GPs), physiotherapists, advanced scope physiotherapists, and orthopedic surgeons—revealed differing opinions regarding the most appropriate treatment pathways for FS[42]. Despite these variations, there is general agreement that treatment should be tailored to the disease stage and that a stepwise approach should be followed, progressing from less to more invasive interventions as needed[43,38,42,44]. Evidence suggests that aggressive mobilization should be avoided during the early, painful phase of FS[38,36,44]. Surgical interventions are typically reserved for cases that do not respond to conservative management[44], though there is no consensus on the specific pain threshold or time frame that should prompt surgical intervention[42].
According to the recent UK survey, the most commonly recommended treatments during the painful phase of FS were:

- Conservative management (including patient education, pain relief, and watchful waiting) – recommended in approximately one-third of responses.
- Physiotherapy and mobilization – also recommended in one-third of responses.
- Intra-articular corticosteroid injections – recommended by 18% of respondents.

For patients in the resolution phase, the preferred intervention was surgery (MUA or arthroscopic capsular release), endorsed by nearly half of respondents, followed by:

- Physical therapy – recommended by 19%.
- Conservative treatment – recommended by 12%.

Conclusion:

Existing research strongly supports a significant association between diabetes and frozen shoulder. However, the precise underlying mechanisms remain unclear, highlighting the need for further studies to investigate the multifactorial nature of this condition. While manual therapy and exercise-based physiotherapy continue to be the primary treatment approaches, there is a lack of research on physiotherapy protocols specifically tailored to different levels of tissue irritability.

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