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Frequency of Pre-Diabetes and Diabetes in Cases of Adhesive Capsulitis: A Cross-Sectional Study

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Abstract

Background: Adhesive capsulitis (frozen shoulder) is a chronic musculoskeletal disorder associated with significant functional disability. Increasing evidence links this condition with metabolic disorders, particularly diabetes mellitus and pre-diabetes. However, the frequency of dysglycaemia in patients presenting with adhesive capsulitis remains understudied in the North Indian population. This study aimed to determine the frequency of pre-diabetes and diabetes in patients with adhesive capsulitis and to evaluate shoulder range of motion in relation to glycaemic status.

Methods: A hospital-based cross-sectional study was conducted at the Department of Orthopaedics, SGRD Hospital, Vallah, Amritsar, from July 2024 to December 2025. One hundred consecutive patients with adhesive capsulitis (non-traumatic shoulder stiffness, restriction in ≥2 planes, age >18 years) were enrolled after written informed consent. Glycosylated haemoglobin (HbA1c) was estimated using the D10-HPLC method and classified per American Diabetes Association 2023 criteria as normoglycaemic (4.5–5.6%), pre-diabetic (5.7–6.4%), or diabetic (≥6.5%). Shoulder range of motion (flexion, abduction, external rotation in abduction and adduction) was measured by goniometry. One-way ANOVA was applied; $p<0.05$ was considered statistically significant.

Results: The 51–60-year age group was most affected (37%), with a mean age of 56.3 years. A marked female preponderance was noted (67% vs. 33%). HbA1c revealed 44% diabetic, 26% pre-diabetic, and 30% normoglycaemic patients, yielding a combined dysglycaemia prevalence of 70%. Only 37% had a known prior diagnosis of diabetes; the remaining dysglycaemic cases were newly detected. Most patients (49%) presented within 3–6 months of symptom onset. ANOVA showed no statistically significant differences in shoulder flexion ($p=0.654$), abduction ($p=0.578$), external rotation in abduction ($p=0.340$), or external rotation in adduction ($p=0.340$) across glycaemic categories.

Conclusions: Seventy percent of patients with adhesive capsulitis demonstrated impaired glucose metabolism, with a substantial proportion being previously undiagnosed. Routine HbA1c screening is recommended for all patients presenting with frozen shoulder. Glycaemic status did not significantly influence the degree of shoulder motion restriction at presentation, suggesting hyperglycaemia contributes to disease initiation rather than modulating acute clinical severity.

Keywords: Adhesive capsulitis, Frozen shoulder, Diabetes mellitus, Pre-diabetes, HbA1c, Glycosylated haemoglobin, Range of motion, Dysglycaemia.

Introduction

Adhesive capsulitis, commonly referred to as frozen shoulder, is a chronic and often debilitating musculoskeletal disorder characterised by progressive pain and restriction of both active and passive glenohumeral range of motion. First described by Codman in 1934, the condition involves capsular thickening, synovial inflammation, and adhesion formation between the joint capsule and the humeral head [1–3]. Clinically, it presents with an insidious onset of poorly localised shoulder pain—typically exacerbated at night—followed by progressive loss of mobility, severely affecting activities of daily living such as dressing, grooming, and reaching overhead.

Although traditionally regarded as self-limiting, resolving over one to three years, up to 50% of patients continue to experience

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residual symptoms beyond this period, and a subset require invasive intervention such as manipulation under anaesthesia or arthroscopic capsular release [4, 5]. The condition follows a classical triphasic course: a painful 'freezing' phase (2–9 months), a 'frozen' phase of peak stiffness (4–12 months), and a 'thawing' phase of gradual mobility restoration (5–26 months) [20].

Beyond its musculoskeletal manifestations, adhesive capsulitis is strongly associated with systemic metabolic disorders, particularly diabetes mellitus and pre-diabetes. It has been described as one of the most common musculoskeletal complications of diabetes, with prevalence estimates of 10–38% among diabetic patients compared to 2–5% in the general population [6, 7]. Advanced glycation end-products (AGEs), accumulating under chronic hyperglycaemia, promote collagen cross-linking and capsular fibrosis, a mechanistic link substantiated by molecular and genetic studies [8, 9].

A significant proportion of patients presenting with adhesive capsulitis harbour previously undiagnosed dysglycaemia [10, 11]. Pre-diabetes—a state of impaired glucose regulation preceding overt diabetes—has been identified in up to 37.5% of patients with primary frozen shoulder, suggesting that adhesive capsulitis may serve as an early indicator of metabolic dysfunction [12]. Early identification offers a critical window for lifestyle intervention and prevention of long-term systemic complications.

Despite robust evidence from Western and East Asian populations, data from tertiary orthopaedic centres in North India remain limited. The present study was therefore undertaken to determine the frequency of pre-diabetes and diabetes in patients presenting with adhesive capsulitis at a tertiary care institute in Amritsar, Punjab, and to evaluate shoulder range of motion across glycaemic categories.

Table 1: Age distribution of patients (n=100)

Age group (years)	Number of cases	Percentage (%)
30–40	12	12
41–50	22	22
51–60	37	37
61–70	23	23
>70	6	6
Total	100	100

SD, standard deviation. The majority of patients (60%) were aged 51–70 years.

Table 2: Gender distribution of patients (n=100)

Gender	Number of cases	Percentage (%)
Female	67	67
Male	33	33
Total	100	100

Female-to-male ratio approximately 2:1.

Table 3: Distribution of patients according to HbA1c level (n=100)

HbA1c (%)	Category	Number of cases	Percentage (%)
4.5–5.6	Normoglycaemic	30	30
5.7–6.4	Pre-diabetic	26	26
≥6.5	Diabetic	44	44
—	Total	100	100

Overall, 70% of patients had HbA1c ≥5.7%, indicating impaired glucose regulation.

Material and methods

Study design and setting

This was a hospital-based, cross-sectional, observational study conducted at the Department of Orthopaedics, SGRD Hospital attached to Sri Guru Ram Das Institute of Medical Sciences and Research (SGRDIMSAR), Vallah, Amritsar, from July 2024 to December 2025.

Sample size and sampling

A time-based consecutive sampling method was employed. All eligible and consenting patients diagnosed with adhesive capsulitis presenting to the Orthopaedic Outpatient Department during the study period were enrolled. A total of 100 patients met the eligibility criteria.

Inclusion criteria

(a) Age ≥18 years; (b) history of non-traumatic shoulder stiffness; (c) restriction of shoulder movement in a minimum of two planes on both active and passive examination.

Exclusion criteria

(a) History of previous surgery on the affected shoulder; (b) confirmed rotator cuff tear on imaging; (c) congenital limb abnormalities; (d) documented history of arthritis affecting the shoulder.

Clinical assessment

After obtaining written informed consent, a detailed clinical history was recorded and general physical and local examination performed. Shoulder pain was assessed

Table 4: Distribution of patients according to prior history of diabetes (n=100)

Prior history of diabetes	Number of cases	Percentage (%)
No	63	63
Yes	37	37
Total	100	100

33 of 70 dysglycaemic patients (47%) had no prior diabetes diagnosis; their glycaemic status was detected de novo on HbA1c estimation.

Table 5: Duration of frozen shoulder symptoms at presentation (n=100)

Duration (months)	Number of cases	Percentage (%)
<3	31	31
3–6	49	49
7–9	4	4
9–12	10	10
>12	6	6
Total	100	100

80% of patients presented within six months of symptom onset, corresponding to the freezing and early frozen phases.

Table 6: Comparison of shoulder flexion across HbA1c categories

HbA1c (%)	Flexion Mean ± SD (°)	F value (df)	p-value
4.5–5.6	103.00 ± 16.54		
5.7–6.4	99.42 ± 15.12	0.426 (2, 97)	0.654
≥6.5	99.66 ± 16.58		

ANOVA. No statistically significant difference in shoulder flexion across glycaemic groups.

using the Visual Analogue Scale (VAS) and arc-of-motion pain testing. Plain radiographs were obtained in all patients to exclude other structural pathology (glenohumeral osteoarthritis, calcific tendinitis, fracture).

Glycosylated haemoglobin (HbA1c) was estimated in all patients using the D10-HPLC (High-Performance Liquid Chromatography) method [45]. Patients were classified per American Diabetes Association (ADA) 2023 diagnostic criteria [46] as: normoglycaemic (HbA1c 4.5–5.6%); pre-diabetic (HbA1c 5.7–6.4%); diabetic (HbA1c ≥6.5%).

Shoulder range of motion was measured using a standard goniometer for four movements: flexion, abduction, external rotation in abduction, and external rotation in adduction. All measurements were performed by a single trained examiner to minimise inter-observer variability.

Statistical analysis

Data were entered into Microsoft Excel and analysed using IBM SPSS Statistics version 23.0 (IBM Corp., Armonk, NY, USA). Continuous variables were expressed as mean ± standard deviation (SD); categorical variables as frequencies and percentages. One-way ANOVA was used to compare shoulder range-of-motion parameters across glycaemic categories. A p-value of <0.05 was considered statistically significant; all tests were two-tailed.

Ethics

The study was conducted in accordance with the Declaration of Helsinki. Ethical clearance was obtained from the Institutional Ethics Committee of SGRDIMSAR (Ref. No.: [IEC Ref.]). Written informed consent was obtained from each participant prior to enrolment.

Results

One hundred patients with adhesive capsulitis were studied. Demographic, glycaemic, and clinical findings are presented in Tables 1–9.

The 51–60-year age group accounted for the largest proportion of cases (37%), followed by the 61–70-year group (23%) and 41–50-year group (22%). Only 12% were in the 30–40-year group and 6% were older than 70 years, confirming that adhesive capsulitis predominantly affects middle-aged and older individuals.

A clear female predominance was demonstrated, with females comprising 67% and males 33% of the study population.

The largest proportion (44%) had HbA1c ≥6.5%, consistent with diabetes mellitus; 26% were in the pre-diabetic range (5.7–6.4%) and 30% were normoglycaemic. Collectively, 70% of the study population demonstrated dysglycaemia.

Only 37% had a previously established diagnosis of diabetes. Given that 70% of the cohort had HbA1c ≥5.7%, a substantial majority of glycaemic abnormalities (33 of 70 cases) were newly identified through HbA1c estimation at the time of orthopaedic evaluation.

The majority (49%) presented within 3–6 months and a further 31% within three months of symptom onset. Only 20% had symptoms lasting beyond six months at the time of presentation.

One-way ANOVA comparing all four shoulder range-of-motion parameters across the three HbA1c categories revealed no statistically significant differences in any movement plane

Table 7: Comparison of shoulder abduction across HbA1c categories

HbA1c (%)	Abduction Mean ± SD (°)	F value (df)	p-value
4.5–5.6	84.00 ± 16.53		
5.7–6.4	80.19 ± 14.46	0.551 (2, 97)	0.578
≥6.5	80.00 ± 15.29		
ANOVA. No statistically significant difference in shoulder abduction across glycaemic groups.			

Table 8: Comparison of external rotation in abduction across HbA1c categories

HbA1c (%)	Ext. Rotation Abduction Mean ± SD (°)	F value (df)	p-value
4.5–5.6	24.67 ± 5.07		
5.7–6.4	22.50 ± 4.53	1.092 (2, 97)	0.34
≥6.5	23.75 ± 5.41		
ANOVA. No statistically significant difference in external rotation in abduction.			

Table 9: Comparison of external rotation in adduction across HbA1c categories

HbA1c (%)	Ext. Rotation Adduction Mean ± SD (°)	F value (df)	p-value
4.5–5.6	18.50 ± 5.28		
5.7–6.4	16.35 ± 5.21	1.092 (2, 97)	0.34
≥6.5	17.50 ± 5.55		
ANOVA. No statistically significant difference in external rotation in adduction.			

(Tables 6–9). Although mean values were marginally lower in the dysglycaemic groups compared with the normoglycaemic group across all four movements, none reached statistical significance.

Discussion

The present study examined the frequency of pre-diabetes and diabetes in 100 patients presenting with adhesive capsulitis at a tertiary orthopaedic centre in North India. The principal findings were: (i) a strikingly high prevalence of dysglycaemia (70%), with 44% meeting criteria for diabetes and 26% for pre-diabetes on HbA1c estimation; (ii) a substantial proportion (33 of 70 dysglycaemic cases, i.e. 47%) were newly detected at the time of orthopaedic evaluation; and (iii) no statistically significant association was found between glycaemic status and shoulder range of motion at presentation.

Age and gender distribution

The peak incidence in the 51–60-year age group (37%), with 60% of patients aged 51–70 years, closely mirrors published epidemiological data. Millar et al.[20] identified an incidence peak around 55 years, and Dyer et al.[38] confirmed an increasing risk with advancing age. Age-related degenerative changes in capsular collagen, reduced vascularity, and progressive accumulation of advanced glycation end-products predispose the ageing shoulder capsule to inflammation and fibrosis [42].

A pronounced female predominance (67%) was observed, consistent with multiple prior studies reporting that women account for 60–70% of adhesive capsulitis cases [20, 42]. Perimenopausal oestrogen decline alters collagen metabolism, joint laxity, and immune-inflammatory responses within the glenohumeral capsule, likely contributing to this sex disparity.

Glycaemic status and frequency of dysglycaemia

The combined dysglycaemia prevalence of 70% in the present study is consistent with seminal reports. Tighe and Oakley [23] found diabetes in 41.1% and pre-diabetes in 28.4% of their adhesive capsulitis cohort (combined 71.5%). Pandey et al. [12] reported pre-diabetes in 37.5% of patients with primary frozen shoulder using HbA1c. Zreik et al. [19] documented, in a meta-analysis, an overall diabetes prevalence of approximately 30% among adhesive capsulitis patients—significantly higher than in age-matched general population controls.

Critically, 33 of 70 dysglycaemic patients (47%) had no prior diagnosis of diabetes. This rate of newly detected dysglycaemia aligns with findings by Rai et al. [27] (diabetes in 27.4%; pre-diabetes in 15.5%, all undiagnosed) and Hassankhani et al. [11] (36% diabetic prevalence in a frozen shoulder cohort), and reinforces the recommendation that all patients presenting with frozen shoulder undergo routine metabolic screening with HbA1c.

The causal relationship between hyperglycaemia and adhesive capsulitis has been corroborated by longitudinal and genetic evidence. Kim et al. [17] demonstrated, in a nationwide Korean cohort of 3.47 million individuals, significantly elevated hazard ratios for adhesive capsulitis in both pre-diabetic (HR 1.08; 95% CI 1.07–1.09) and diabetic (HR 1.47; 95% CI 1.45–1.49) patients versus normoglycaemic controls. Green et al. [30] identified five genome-wide significant loci associated with frozen shoulder in the UK Biobank and confirmed through Mendelian randomisation that type 1 diabetes is a causal risk factor (OR 1.03; p=3×10–6). Li et al. [47] further supported causality using a two-sample Mendelian randomisation approach. Pathophysiologically, chronic hyperglycaemia promotes non-enzymatic glycation of capsular collagen, upregulation of pro-fibrotic cytokines (IL-6, IL-8, TNF-α, VEGF), and microvascular hypoxia—all of which drive the progressive capsular fibrosis that underpins adhesive capsulitis

[8, 13].

Duration of symptoms

Eighty percent of patients sought medical care within six months of symptom onset, corresponding to the 'freezing' and early 'frozen' phases of the classical triphasic progression described by Millar et al. [20] and Drakes et al. [42] This early presentation pattern is clinically important: it represents a window during which metabolic screening and timely intervention can arrest both glycaemic progression and functional shoulder deterioration.

Range of motion and glycaemic status

ANOVA revealed no statistically significant differences in shoulder flexion, abduction, or external rotation across the three HbA1c categories—a finding broadly consistent with Dyer et al. [5] who reported that while diabetes increases susceptibility to frozen shoulder, glycaemic control does not appear to directly determine the severity of motion restriction at presentation. Younas and Fatima [29] similarly demonstrated that shoulder ROM was significantly reduced in diabetic versus non-diabetic frozen shoulder patients, but a dose-response relationship between HbA1c level and ROM within the diabetic group was not established. Collectively, these observations suggest that diabetes contributes to disease initiation through long-term metabolic and fibrotic mechanisms rather than modulating the acute clinical severity of joint stiffness.

Clinical relevance

HbA1c is a simple, cost-effective, non-fasting single-point investigation reflecting average glycaemia over the preceding 2–3 months. The present findings, corroborated by the broader literature, support mandatory HbA1c estimation in all patients presenting with frozen shoulder. Newly detected dysglycaemia should prompt timely referral to endocrinology, initiation of lifestyle modification, and pharmacological intervention where indicated, with the dual aim of preventing long-term systemic complications of diabetes and optimising the metabolic environment for shoulder recovery.

Conclusions

This cross-sectional study demonstrates that adhesive capsulitis predominantly affects middle-aged and older women and is associated with a strikingly high burden of glycaemic dysregulation: 44% of patients had diabetes mellitus and 26% had pre-diabetes, yielding a combined prevalence of 70%. A substantial proportion of these cases were previously undiagnosed, highlighting the pivotal role of the orthopaedic clinician in early metabolic detection. Although glycaemic status did not significantly influence shoulder range of motion at presentation, these findings strongly support the routine measurement of HbA1c in all patients presenting with frozen shoulder to enable timely metabolic intervention and reduce long-term systemic morbidity.

Limitations

(i) Single-centre design may limit generalisability. (ii) Cross-sectional methodology precludes establishment of causal relationships between glycaemic status and adhesive capsulitis. (iii) Longitudinal changes in glycaemic status and shoulder mobility were not assessed. (iv) Additional metabolic parameters (fasting plasma glucose, OGTT, lipid profile, and BMI) were not included, limiting the metabolic profile of the cohort. (v) Goniometric measurements are subject to intra- and inter-observer variability. (vi) Occupational exposure and physical activity data were collected through self-report and may be subject to recall bias.

Declaration of patient consent: The authors certify that they have obtained all appropriate patient consent forms. In the form, the patient has given his consent for his images and other clinical information to be reported in the Journal. The patient understands that his name and initials will not be published, and due efforts will be made to conceal his identity, but anonymity cannot be guaranteed.

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