

# Range of motion of diabetic frozen shoulder recovers to the contralateral level

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## Abstract

**Objective:** To determine whether frozen shoulder heals equally well in patients with and without diabetes and whether dependency on insulin affects the outcome.

**Methods:** We retrospectively examined 178 patients with idiopathic frozen shoulder; 27 patients had diabetes. We evaluated range of motion, pain, and functional results. The mean follow-up was 9.7 years (SD, 7.1 years).

**Results:** In the presence of frozen shoulder, range of motion did not differ between patients with and without diabetes. At follow-up, range of motion in all directions of both the affected and unaffected shoulders of patients with diabetes was inferior to that of patients without diabetes. Among patients with diabetes, range of motion of the once-frozen shoulder reached the level of the unaffected shoulder. Patients with and without diabetes experienced similar pain except during exertion. The Constant–Murley score was not significantly different between the two groups, and insulin dependency did not lead to worse outcomes.

**Conclusion:** Frozen shoulder heals well in patients with diabetes.

## Keywords

Frozen shoulder, diabetes, outcome

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## Introduction

Frozen shoulder among patients with diabetes is common. Its reported incidence ranges from 10.0% to 36.0% and prevalence ranges from 10.3% to 22.4%.<sup>1,2</sup> In patients with diabetes, problems tend to be more persistent and more difficult to treat; poor results, higher recurrence and inferior function have been reported after nonoperative treatment, manipulation under anaesthesia (MUA), open release or arthroscopic

capsular release.<sup>3–11</sup> Conversely, many researchers have reported no differences in the outcomes of frozen shoulder between patients with and without diabetes.<sup>7,12–24</sup>

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We hypothesized that almost the same outcomes of idiopathic frozen shoulder would be achieved in patients with and without diabetes.

Therefore, in the present study, we retrospectively examined 178 patients (198 shoulders) with frozen shoulder, including 27 patients with diabetes (29 shoulders). We evaluated long-term range of motion (ROM), pain relief and functional results during a follow-up period of 2 to 28 years (mean,  $9.7 \pm 7.1$  years). We also studied whether dependence on insulin affected the outcome. This study is important because the results of earlier studies concerning the outcome of frozen shoulder in patients with diabetes are very controversial.

## Patients and methods

### *Ethics statement*

We obtained permission to perform this study from the ethics committee of the study's hospital district and followed the guidelines of the Helsinki declaration. All participants provided written informed consent before participation. This research received no specific grant from any funding agency in the public, commercial, or not-for-profit sectors. The authors declare no conflict of interest in preparing this article.

### *Patients and study design*

Two of the authors (M.V. and H.V.) retrospectively identified 231 patients with spontaneous idiopathic frozen shoulder seen by the senior author from 1975 to 2006 and evaluated 178 of these patients (198 idiopathic frozen shoulders); 27 (15%) of these patients (29 shoulders) had diabetes. The average follow-up time was 9.7 years (SD, 7.1 years). The inclusion criteria were no trauma or only very minor shoulder trauma, marked loss of active and passive shoulder motion (forward flexion  $\leq 135^\circ$ , abduction  $\leq 135^\circ$ , restriction in external rotation),

normal findings in a true anteroposterior radiograph of the glenohumeral joint and no suspicion of rotator cuff tear at the first consultation. The exclusion criteria were intrinsic glenohumeral pathology, such as glenohumeral arthritis or rotator cuff tear; a history of substantial shoulder trauma; previous or subsequent shoulder surgery; reflex sympathetic dystrophy of the ipsilateral hand; previous or subsequent fracture of the same shoulder area; and insufficient medical records (no degrees of ROM mentioned). The patients' basic characteristics are shown in Table 1. Of the 27 patients, 15 (56%) had insulin-dependent diabetes mellitus (17 shoulders) and 11 used no insulin, and 1 patient with diabetes used only dietary treatment. The mean age of all patients at the first consultation was 52.6 years (range, 32–69 years) (with diabetes, 50 years; without diabetes, 53 years;  $p=0.034$ ). All patients had flexion of  $\leq 135^\circ$  while their shoulder was frozen.

Of all 198 frozen shoulders, 110 (56%) underwent MUA. The other 88 shoulders underwent either conservative treatment or observation. A total of 20 (11.2%) verified bilateral frozen shoulders (2 patients with diabetes) fulfilled the inclusion criteria. The right shoulder was involved in 43% of patients. Of all 178 patients, 18% related their onset of symptoms to some kind of provocative action, such as throwing a rope.

### *Clinical evaluation*

Initial evaluation included a detailed medical history, physical examination, and anteroposterior radiographs. Most patients had already undergone shoulder radiographs before the first consultation. No subjective assessment occurred at this initial evaluation. Each of the 178 patients underwent a physical examination by an independent observer (H.V.) at the final follow-up similar to that in the first consultation. The observer assessed shoulder function with the Constant–Murley

**Table 1.** Characteristics of patients with frozen shoulder.

	All n = 178	Diabetes n = 27	Without diabetes n = 151	p-value*
Age at first consultation	52.6 (7.0)	50 (8.5)	53 (6.7)	0.034
Age at second consultation	62 (8.2)	60 (9.3)	63 (8.0)	0.101
Follow-up time, years	9.7 (7.1)	9.7 (7.2)	9.6 (6.9)	0.905
Shoulders, n	198	29	169	
Treatment, 198 frozen shoulders				
Conservative, n (%)	88 (44.4)	9 (31.0)	79 (37.3)	0.268
Manipulation under anaesthesia, n (%)	110 (55.6)	20 (69.0)	90 (53.3)	0.501

Data are presented as mean (SD) unless otherwise indicated.

\*p-value is between patients with and without diabetes.

score and shoulder strength by manual muscle testing; strength in abduction was assessed using a Salter spring balance up to 11 kg at increments of 0.2 kg.<sup>25</sup> The presence of a painful arc sign was indicated by “yes” or “no.” Additionally, a true anteroposterior radiograph of the index shoulder was taken in external rotation.

### Questionnaire survey

Patients received questionnaires<sup>25</sup> before the final follow-up. The questionnaires assessed demographics and symptoms of the once-frozen shoulder, including pain evaluation on a visual analogue scale (VAS) (range, 0–10; 0 = no pain to 10 = maximal imaginable pain). Additionally, patients received the Simple Shoulder Test. The Ethics Committee of Helsinki University Hospital District approved this study (No. 107, 19.9.2007).

### Statistical analyses

Differences in age, follow-up time, and ROM while the shoulder was frozen and during follow-up between patients with and without diabetes and between patients with insulin-dependent and non-insulin-dependent diabetes were determined using a t-test; differences in dichotomous variables were evaluated with Pearson’s chi-square test.

Differences in shoulders between patients with and without diabetes were assessed by a paired-sample t-test. The statistical significance threshold was set at  $p < 0.05$  (two-tailed). All statistical analyses were performed with SPSS software (version 23.0; IBM Corp., Armonk, NY, USA).

## Results

### ROM

ROM while the shoulder was frozen at the same mean disease stage (8 vs. 7 months from onset of symptoms) was not significantly different between the 29 shoulders in patients with diabetes and 169 shoulders in patients without diabetes (Table 2). At the final follow-up, ROM of the affected shoulders in patients without diabetes improved to the contralateral healthy level, but ROM of the affected shoulders in patients with diabetes remained below the contralateral level of patients without diabetes ( $p < 0.001$ – $0.008$ ). However, the final ROM was not significantly different between the affected and contralateral unaffected shoulders in patients with diabetes. The mean difference between the ROM in the affected and unaffected shoulders in patients with diabetes was  $5^\circ$  in flexion,  $5^\circ$  in abduction,  $1^\circ$  in external rotation, and  $0^\circ$  (no difference) in internal rotation. Comparison of the

**Table 2.** Initial range of motion and outcomes of frozen shoulder in patients with and without diabetes.

	Diabetes	No diabetes	p-value of affected shoulders (diabetes vs. no diabetes)	Unaffected shoulder (diabetes)	Unaffected shoulder (no diabetes)	p-value of unaffected shoulders (diabetes vs. no diabetes)	p-value in patients with diabetes (affected vs. unaffected shoulder)
Shoulders (patients)	29 (27)	169 (151)					
Age at FS during first consultation, years	50 (8)	53 (7)	0.048				
Duration of symptoms at first consultation, months	8	7	0.178				
During frozen shoulder							
Flexion	93 (29)	101 (18)	0.197				
Abduction	83 (29)	86 (24)	0.597				
External rotation	23 (17)	22 (16)	0.881				
Internal rotation	Below buttock	Above buttock	0.178				
At final follow-up							
Flexion	144 (19)	157 (14)	0.001	149 (15)	157 (16)	0.019	0.172
Abduction	154 (36)	173 (16)	0.008	154 (29)	169 (27)	0.048	0.262
External rotation	41 (19)	53 (14)	0.002	40 (20)	52 (14)	0.008	0.744
Internal rotation	LIII	ThXII	<0.001	LIII	ThXII	0.005	0.970
Pain during exertion VAS	2.5 (2.9)	1.4 (2.3)	0.034				
Pain at rest VAS	0.9 (1.3)	0.6 (1.3)	0.403				
Pain at night VAS	1.5 (2.2)	0.9 (1.8)	0.200				
Simple Shoulder Test score	9 (3)	11 (2)	0.005				
Constant-Murley score	76 (16)	82 (12)	0.055				
Follow-up time, years	10.0 (8)	9.7 (7)	0.849				

Data are presented as mean (SD) unless otherwise indicated.

FS, Frozen shoulder; VAS, visual analogue scale

**Table 3.** Initial range of motion and outcomes of frozen shoulder in patients with insulin-dependent and non-insulin-dependent diabetes.

	Insulin-dependent diabetes	Non-insulin-dependent diabetes	p-value
Patients (shoulders), n	15 (17)	12 (12)	
Age at FS, years	47.7 (8.9)	53.3 (6.9)	0.078
Follow-up time, years	9.9 (7.4)	10.1 (8.2)	0.935
Age at follow-up, years	57.6 (10.1)	63.4 (6.9)	0.094
During frozen shoulder			
Flexion	93 (34)	93 (24)	0.936
Abduction	83 (30)	84 (28)	0.850
External rotation	15 (14)	33 (15)	0.054
Internal rotation	Below buttock	SI	0.009
At final follow-up			
Flexion	141 (18)	148 (19)	0.327
Abduction	151 (40)	158 (29)	0.595
External rotation	34 (18)	49 (18)	0.035
Internal rotation	LIII	LIII	1.000
Other shoulder flexion	147 (18)	145 (16)	0.808
Other shoulder abduction	153 (37)	157 (23)	0.775
Other shoulder external rotation	43 (20)	48 (15)	0.514
Other shoulder internal rotation	LIII	LII	0.755
Pain* during exertion	2.6 (3.0)	2.3 (3.0)	0.318
Pain* at rest	0.6 (1.0)	1.1 (1.5)	0.816
Pain* at night	1.4 (2.1)	1.5 (2.5)	0.907
Simple Shoulder Test score	9 (3)	10 (3)	0.412
Constant–Murley score	77 (16)	76 (17)	0.868

Data are presented as mean (SD) unless otherwise indicated.

FS, Frozen shoulder; SI, Sacral I; VAS, visual analogue scale

\*Pain on VAS (0–10): 0 = no pain and 10 = maximal imaginable pain.

affected versus unaffected shoulders between patients with and without diabetes revealed no significant difference. Manipulated shoulders of those with diabetes had similar ROM at final follow-up as did others with diabetes and frozen shoulders treated conservatively (follow-up: flexion, 145° vs. 140°; abduction, 153° vs. 155°; external rotation, 36° vs. 50°; internal rotation, L III vs. L III).

While the shoulder was frozen, patients with insulin-dependent diabetes had worse internal rotation and a greater tendency toward inferior external rotation than did patients with non-insulin-dependent

diabetes (15° vs. 30°), but without statistical significance (Table 3). However, they had significantly worse inferior external rotation at the follow-up ( $p=0.035$ ). Other outcomes were similar between patients with insulin-dependent and non-insulin-dependent diabetes.

Three patients with diabetes (11%) had a follow-up ROM (flexion + abduction + external rotation) of <220° (215°, 190° and 190°); one of them had internal rotation to the L4 level, and the other two had internal rotation only below the buttock. Their Constant–Murley scores were 45.0, 40.6 and 34.0, respectively; one of them was

totally painless, and the others had a VAS score of 2.2 and 3.1, respectively, at rest.

### **Pain**

Patients without diabetes reported significantly less pain during exertion than did patients with diabetes according to their VAS score (1.4 vs. 2.5, respectively;  $p=0.034$ ), but their pain at night (0.9 vs. 1.5) and during rest (0.6 vs. 0.9) were as low as those in patients with diabetes (Table 2). A total of 44% of patients without diabetes and 28% of patients with diabetes had totally painless shoulders; nine (6.0%) patients without diabetes and two (7.4%) patients with diabetes had a VAS pain score of  $>3$  with exertion, at rest and at night. No difference in pain was present between patients with insulin-dependent and non-insulin-dependent diabetes (Table 3), nor was there any significant difference in follow-up pain in patients with diabetes who underwent conservative treatment versus MUA.

### **Functional outcome**

The Constant–Murley score was better in patients without than with diabetes, but the difference was not significant (82 vs. 76, respectively). However, the Simple Shoulder Test score was significantly better in patients without than with diabetes (11 vs. 9, respectively;  $p=0.005$ ) (Table 2). No difference was observed in functional scores between patients with insulin-dependent and non-insulin-dependent diabetes (Table 3).

Patients with diabetes had a positive painful arc sign significantly more often than did patients without diabetes (23% vs. 6%, respectively), but crepitus in the affected glenohumeral joint was detected as rarely (13% vs. 12%, respectively). Radiological findings such as cystic degeneration or sclerotic change at follow-up were not correlated with diabetes.

## **Discussion**

Most of the findings in the present study support our hypothesis regarding the outcome of frozen shoulder in patients with diabetes. We hypothesized that their outcome would be similar to that of patients without diabetes. While the shoulder was frozen, both at 7 to 8 months and 10 to 11 months from onset of symptoms, shoulder ROM was similar between patients with and without diabetes. Likewise, Cinar et al.<sup>3</sup> found no significant differences in the pre-operative functional scores between these groups of patients with frozen shoulder.

In the present study, the follow-up ROM in patients with diabetes was inferior to that of patients without diabetes in all directions. According to Griggs et al.,<sup>4</sup> diabetes in patients with frozen shoulder is associated with worse outcomes in terms of ROM. The results of arthroscopic capsular release for frozen shoulder in patients with diabetes are also worse in terms of ROM.<sup>3</sup> Mehta et al.<sup>8</sup> reported significant improvement ( $p < 0.01$ ) in the modified Constant scores following arthroscopic release for frozen shoulder in 21 patients with diabetes and 21 patients without diabetes. The patients with diabetes had significantly worse outcomes than those without diabetes 6 months postoperatively ( $p < 0.01$ ) with a tendency toward persistent limitation of movement 2 years postoperatively. Patients with diabetes reportedly also have inferior results after open surgical release.<sup>9</sup> At follow-up in the present study, however, the ROM of our patients' once-frozen shoulder reached the same level as their unaffected shoulder. The ROM in the frozen shoulder was not inferior to that in their own unaffected shoulder. This is the main finding in the present study that differs from the results of other studies. We found no other studies that compared the outcome ROM between the once-frozen and unaffected shoulder in the same patients with diabetes.

Many studies have shown that diabetes is not a risk factor affecting either the objective

or subjective outcome of frozen shoulder after nonoperative treatment.<sup>13,14,16,18,20,26</sup> Düzgün et al.<sup>14</sup> found no significant differences in ROM, functional activity status, pain level or muscle strength before and after rehabilitation between 12 frozen shoulders in patients with diabetes and 38 frozen shoulders in patients without diabetes. In other studies, diabetes did not affect the outcome after arthroscopic capsular release,<sup>15,22</sup> after MUA<sup>12,21</sup> or between patients treated operative and nonoperatively.<sup>17</sup> Some authors, however, report conflicting results.<sup>27,28</sup> In the present study, the ROM in patients with diabetes recovered to the ROM level of their own contralateral shoulder, but not to the ROM level of that in patients without diabetes.

Patients with insulin-dependent diabetes are more likely to require arthroscopic release than are patients with non-insulin-dependent diabetes.<sup>29</sup> In the present study, insulin-dependence showed no effect on flexion or abduction while the shoulder was frozen or on the outcome of pain or function; however, the outcome of external rotation was inferior. If a patient's history of insulin-dependent diabetes is >10 years, only about 25% of patients partially respond to manipulation alone.<sup>30</sup> However, the duration of diabetes in the patients of the present study is unknown.

In one study, pain was present in 26% of patients with diabetes but in no patients without diabetes.<sup>3</sup> In another study, the average VAS pain score was 4.3 among patients with diabetes and 1.1 among those without diabetes after open surgical release.<sup>9</sup> In the present study, the outcome concerning pain was similar between patients with and without diabetes at rest and during the night, but was slightly worse during exertion.

With respect to function, one study showed that the average Constant–Murley score was 82 in patients with diabetes and 94 in patients without diabetes ( $p < 0.05$ ).<sup>3</sup> Other studies showed average American

Shoulder and Elbow Surgeons shoulder scores of 61 and 75<sup>9</sup> and Oxford Shoulder Scores of 41 and 43, respectively ( $p < 0.001$ ).<sup>7</sup> The Constant–Murley scores in the present study were in accordance with our hypothesis. However, patients with diabetes self-evaluated their function as being inferior to that of controls in the Simple Shoulder Test.

Frozen shoulder (patients) with diabetes mellitus have a more severe course and more resistance to treatment compared to (general population) with frozen shoulder.<sup>7,31,32</sup> The proportion of patients with diabetes was much greater than that of patients without diabetes among those who developed recurrence after MUA. One-half of the patients with insulin-controlled diabetes and one-quarter of those with non-insulin-controlled diabetes required a second MUA.<sup>11</sup> The outcomes of MUA in the present study, however, do not support this. Patients with diabetes also reportedly have inferior results after open surgical release,<sup>9</sup> and one study showed that patients with diabetes had slower postoperative functional recovery during the first 12 months following arthroscopic capsular release.<sup>33</sup>

We acknowledge that the present study has limitations. First, we did not obtain the Constant–Murley scores or the Simple Shoulder Test scores when the patients were initially examined. However, ROM and strength measurements were available. Second, we presented pooled data comprising 45% patients not yet appearing in the literature. We consider this adequate, however, because the purpose of the earlier papers was not to compare patients with or without diabetes and because our study schedule was similar for all patients.

The mean follow-up time in the 12 studies that showed no effect or a questionable effect of diabetes on the outcome of frozen shoulder was 2.5 years (range, 0.1–7.0 years), with a mean of 14 (range, 3–28) patients per study. The 3 studies<sup>2,6,8</sup> that reported inferior results of frozen shoulder in

patients with diabetes had a mean follow-up time of 3.0 years (range, 1.6–4.0 years) and a mean of 19 (range, 6–22) patients with diabetes. Our clinical follow-up time was 9.9 years among 29 shoulders in patients with diabetes. We found no studies exceeding our clinical follow-up time or exceeding our number of frozen shoulders in patients with diabetes. Jenkins et al.<sup>7</sup> reported the 3.4-year outcome for 22 diabetic patients with frozen shoulder in a questionnaire study with a mean clinical follow-up time of only 3 weeks.

In terms of what this study adds to existing knowledge, we have shown that the follow-up ROM of the once-frozen shoulders in patients with diabetes reach the same level as their own unaffected shoulders. Additionally, we have confirmed the results of some other authors showing that there are otherwise no differences in outcomes in frozen shoulders between patients with and without diabetes. This leads us to believe that frozen shoulder actually heals as well in patients with diabetes as in patients without; other diabetes-related factors appear to cause joint mobility to worsen over time in this patient population.

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### Declaration of conflicting interest

The authors declare that there is no conflict of interest.

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