Prevalence of symptoms and signs of shoulder problems in people with diabetes mellitus

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Diabetes mellitus is a known risk factor for frozen shoulder. This study was performed to quantify this association and test any relationship with other risk factors for diabetic complications. Patients attending diabetic (n = 865) and general medical (n = 202) clinics were interviewed and examined. External rotation was measured in both shoulders. Glycated hemoglobin A1c was measured in all diabetic patients. Frozen shoulder was defined as pain for more than 3 months and external rotation of less than 50% of the unaffected shoulder. Bilateral frozen shoulder was defined as external rotation of less than 30° in both shoulders. Shoulder pain was present in 25.7% of diabetic patients compared with 5.0% of general medical patients. The criteria for frozen shoulder were fulfilled in 4.3% of diabetic patients and in 0.5% of the general medical patients. Only duration of diabetes had a positive association. The prevalence of painful or stiff shoulder was greater in diabetic patients than general medical patients. The prevalence of frozen shoulder is less than previously reported but still greater in diabetic patients. (J Shoulder Elbow Surg 2007;16: 748-751.)

Diabetes mellitus has many complications, the most well-described being atheromatous cardiovascular disease and microvascular complications such as retinopathy and nephropathy.8,13,16 Complications involving the musculoskeletal system, especially the shoulder joint, are less well-described and understood.

Adhesive capsulitis of the shoulder, or frozen shoulder (FS), is the most common and disabling of all shoulder abnormalities. The symptom of progressive, painful restriction of shoulder movement is caused by a thickened joint capsule that is adherent to the humeral head. The clinical course of the disease is characterized by 3 main phases: painful, adhesive, and resolution.14

A number of studies have described an increased prevalence of FS in people with diabetes. Bridgman et al6 conducted a large published study that described this association. Two further smaller studies have also revealed a higher incidence of musculoskeletal problems in patients with diabetes.4,7 Although these studies revealed increased prevalence of FS in the diabetic population that was correlated with age, sex, and duration of diabetes, they, in general, did not have strict criteria for defining FS. The present study examines the prevalence of FS in a diabetic population compared with a population of nondiabetic patients attending hospital clinics, using strict criteria for defining FS, and examines the association between the presence of FS and glycemic control.

MATERIALS AND METHODS

This study was performed in a large teaching hospital in a major urban location. During a 3-month span, all patients attending a diabetic clinic or a general medical clinic were approached and asked to fill out a short questionnaire inquiring about the presence of shoulder pain and stiffness. Patients with shoulder pain or stiffness were identified, and informed consent was obtained. Excluded from further analysis were patients in either group who had a significant injury to their shoulder that required orthopedic treatment or who had inflammatory arthritis, such as rheumatoid arthritis, or psoriatic arthritis.

Subjects were asked to complete an additional questionnaire about their medical and orthopedic history. Diabetes-related questions included method of control (eg, diet, tablet, or insulin) and duration of diabetes. Patients were asked about duration of their shoulder pain, previous trauma, or inflammatory arthritis, and any prior diagnosis or treatment for their shoulder.

Examination consisted of a measurement of passive external rotation of each shoulder using a goniometer. Frozen shoulder was defined as pain for more than 3 months with a reduction of external rotation of more than 50% compared with the unaffected shoulder.12 Also included were those patients with bilateral FS, defined as pain for more than 3 months and both shoulders restricted to less than 30° external rotation.
Glycated hemoglobin $A_1c$ ($HbA1c$) measurements were aligned with the Diabetic Control and Complications Trial (DCCT), with the nondiabetic rate being less than 6%. The same process was undertaken in the general medical clinic, except no blood sample was taken for $HbA1c$. All patients were asked if they had diabetes, and those who had were allocated to the diabetic group. Case-note review was used for gathering data on clinical characteristics of patients such as type and duration of diabetes.

Statistical analysis was then performed to assess the relationship between FS and the presence, type, and duration of diabetes; age, glycemic control, and method of glycemic control (use of insulin).

RESULTS

During a 3-month span, 865 consecutive patients with diabetes completed an initial questionnaire. Of those 865 patients, 850 were seen at the diabetes clinic and 15 were seen in the general medical clinic. During the same period, 202 nondiabetic patients (controls) in the general medical clinic were approached and questioned.

Men comprised 49% of the diabetic cohort and 43% of the control group. Of the 865 diabetic patients, 222 (25.7%) stated they had shoulder pain compared with 10 (5.0%) of the control group ($P < .001$, $\chi^2$ test). Seventy-one of the diabetic patients were excluded from further assessment because they had a history of trauma or inflammatory arthropathy, and 16 were unable to cooperate with the examination. Three nondiabetic patients were excluded on these grounds.

Of the 778 diabetic patients not excluded, 34 (4.4%) fit the criteria for FS compared with 1 (0.5%) control subject ($P = .005$, $\chi^2$ test). Within the diabetic group, 14 had unilateral FS and 20 had bilateral FS. More men than women with diabetes were diagnosed with FS (59%), but this did not reach statistical significance ($P = .395$, $\chi^2$ test). Age was also not a significant factor for FS ($P = .205$, Student $t$ test). Diabetic patients with FS had a longer duration of diabetes (13.3 years) than those without FS (9.4 years), showing a positive association ($P = .003$, Student $t$ test). Further details of the diabetic subjects with FS are outlined in Table I.

Some evidence was found for an increase in FS among diabetic patients with type 1 diabetes compared with type 2, but this did not reach full statistical significance ($P = .069$, $\chi^2$ test). The difference in $HbA1c$ levels between those with and without FS was not significant ($P = .398$, Student $t$ test). There was also no significant increase in FS in those patients receiving insulin (5.3%) compared with those treated with diet or tablet control (3.3%; $P = .14$, $\chi^2$ test).

Although 116 diabetic patients complained of shoulder pain, they did not fulfill the criteria for FS (13.4%) compared with 6 nondiabetic patients (3.0%). This, in itself, was highly significant ($P < .001$, $\chi^2$ test). There were also 12 diabetic patients (1.5%) who had significant restriction of shoulder joint mobility, defined as a difference of more than 20° between range of passive external rotation between shoulders, without fulfilling the criteria for FS.

DISCUSSION

A number of observational studies have indicated that diabetes is associated with FS. Bridgman et al 6 first recognized this association and published their findings from a large study that investigated the prevalence of FS in 800 diabetic and 600 nondiabetic patients. They defined FS as a history of shoulder pain sufficient to wake the patient at night present for at least 3 months, progressive limitation of shoulder movement, particularly a reduction of at least half the normal range of external rotation, or patients recovering from a well-documented history of the stages of FS, and 10.8% of diabetic patients and 2.3% nondiabetic patients fit these criteria. Although 4.5% diabetic patients were classified as having bilateral disease, the criteria for this diagnosis were not specified.

Subsequent studies have supported the association between diabetes and FS. The prevalence of FS in another of these studies was 19% in diabetic patients compared with 5% in nondiabetic subjects. These authors defined FS as unilateral shoulder pain for at least 1 month, inability to lie on the affected shoulder, and restricted active and passive shoulder joint movements in all planes. This definition was also used to classify patients with FS in 3 other studies, and the rates of FS in the diabetic patients was 10.3% to 29%.

There are problems, however, with this definition of FS. Shoulder movement in most planes involves scapulothoracic mobility (not affected by adhesive capsulitis) to a highly variable degree. To define pathology affecting the glenohumeral joint, external rotation is

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### Table I Characteristics of diabetic patients with and without frozen shoulder

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>All</th>
<th>Without FS</th>
<th>With FS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age, mean, y</td>
<td>58.6</td>
<td>58.5</td>
<td>56.1</td>
</tr>
<tr>
<td>Patients, No.</td>
<td>778</td>
<td>744</td>
<td>34</td>
</tr>
<tr>
<td>Diabetes duration, mean, y</td>
<td>9.8</td>
<td>9.7</td>
<td>13.3</td>
</tr>
<tr>
<td>Type 1 diabetes, %</td>
<td>18.1</td>
<td>18.2</td>
<td>17.6</td>
</tr>
<tr>
<td>Insulin use, %</td>
<td>53.6</td>
<td>52.7</td>
<td>64.7</td>
</tr>
<tr>
<td>$HbA1c$, %</td>
<td>8.3</td>
<td>8.3</td>
<td>8.0</td>
</tr>
</tbody>
</table>

FS, Frozen shoulder; $HbA1c$, glycated hemoglobin.
the best reliable measure because it is the only shoulder movement that takes place exclusively at the glenohumeral joint. Furthermore, a criterion of less than 50% of the normal range of movement (ie, of the unaffected shoulder) ignores those patients with bilateral disease. Our study found the prevalence of FS to be 4.3% in diabetic subjects and 0.5% in a nondiabetic control group, these figures being lower than those seen in other studies. This can be explained by the strict criteria we used for defining FS.

Ideally, our definition should have included a criterion of normal radiographic appearance (apart from possible disuse osteopenia), which would have helped to exclude cases of primary degenerative arthritis. This was not deemed practical, and we accept the possibility that some of the cases labelled as FS may actually be osteoarthritis.

Our technique of measurement of external rotation has some potential drawbacks. The examiner uses perceived torque or pain, which are somewhat subjective, to judge the limit of passive external rotation. Although external rotation is primarily a glenohumeral movement, some scapulothoracic motion is unavoidable unless a scapula-stabilizing technique is used.11 Owing to its difficulty, we did not include this within our protocol. Despite these reservations, we believe that our results remain valid.

Other studies have also looked at correlations between a number of patient characteristics and the presence of FS. Bridgman’s study2 was before the advent of HbA1c measurement but revealed that patients with type 2 diabetes and FS were more likely to require insulin therapy, suggesting that FS may be related to poor glycemic control. Subsequent studies have all analyzed the relationship between glycemic control and FS in diabetes, and, surprisingly, no study, including our own, has revealed a correlation between HbA1c and prevalence of FS. Pal et al12 found that only duration of diabetes was a risk factor and that insulin requirement, HbA1c, and age were unrelated. Arkkila et al2 found that age was a factor in all diabetic patients and duration of diabetes a factor in type 1 patients. We have found that longer duration of diabetes correlates with an increased risk of FS and some evidence for a similar association for type 1 diabetes vs type 2. The lack of full statistical significance may be due to the low number of patients with FS, despite a large study group. Insulin use was not a significant risk factor.

Two other interesting findings emerged from the present study. Although only 4.2% of diabetic patients qualified as having FS, another 13.4% complained of shoulder pain but did not fulfil the criteria for FS compared with 3.0% of controls. Also, 12 diabetic patients (1.5%) had a difference of more than 20° external rotation but movement was not restricted enough to diagnose with FS with our strict criteria. This would seem to be a significant restriction without necessarily being true FS.

A number of studies have shown that diabetic patients have generalized limitation of joint mobility compared with healthy subjects.12,15 The etiology of this association is unclear, but several biochemical abnormalities are seen in this condition, including increased glycosylation of collagen protein and altered collagen synthesis.1,17 In addition, increased formation of advanced glycation end products, which accumulate over time and have been shown to have a detrimental effect on a number of cellular and extracellular processes, may participate in the pathogenesis of this condition.10 The underlying histology in nondiabetic patients with FS has been shown to be a process of fibroplasias and capsular contracture, which is a cytokine-driven, inflammatory, and fibrotic process. The pathophysiology underlying FS in diabetic subjects is unclear. Frozen shoulder is also associated with hand abnormalities in diabetic subjects, such as limited joint mobility5 and Dupuytren disease, and this may reflect the same underlying mechanism.3

The association of FS with glycemic control is as yet controversial, with some investigators providing data in support of a relationship and others against.1,9 There would, therefore, seem to be an overlap in diabetic patients between those with limited joint mobility and those with true FS. Whether the mechanisms behind these entities are related is also unclear. A future study might look at other joints for limited joint mobility and compare the incidence of this with unilateral FS.

To our knowledge, this is the largest study to date that examines the relationship between diabetes and FS. Although the original Bridgman study matches our sample size, the relationship between glycemic control and FS was not properly assessed because the study occurred before the routine measurement of HbA1c levels in patients with diabetes.6 In addition, only the Bridgman,6 Pal et al,12 and Cagliero et al6 studies used nondiabetic controls. This is also the only study to specify and systematically identify bilateral disease and to base the diagnosis on a history of pain with a limited movement in a single plane (external rotation) specific to the glenohumeral joint.

We are sad to report the death of one of the investigators, Ian Kelly, who died suddenly shortly after the study was completed. We are grateful for the assistance of Lynda Cochrane of Ninewells Orthopaedics Academic Department for all statistical analysis. Ethical approval was granted from the North Glasgow Trust Local Research Ethics Committee.

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