# Development of arthrosis following dislocation of the shoulder: A case-control study

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*The goal of this study was to document whether an association exists between shoulder dislocation and the development of arthrosis and to quantify this association, if present. Patients with osteoarthrosis who had undergone hemi-shoulder or total shoulder arthroplasty (TSA) were studied. Patients who had undergone total knee arthroplasty for arthrosis and who had no history of shoulder symptoms served as control subjects. All patients were asked if they had ever sustained a shoulder dislocation. Ninety-one TSA patients and 282 control subjects responded. The odds ratio for developing arthrosis after a shoulder dislocation was 19.3 (P = .000006). With the 5 patients who had shoulder surgery prior to TSA excluded, the odds ratio was 10.5 (P = .003). The risk of developing severe arthrosis of the shoulder is between 10 and 20 times greater for individuals who have had a dislocation of the shoulder. (J Shoulder Elbow Surg 2002;11:1-5.)*

## INTRODUCTION

Shoulder dislocations are common injuries. Epidemiologic studies have demonstrated that 0.5% to 1.7% of individuals have a history of a shoulder dislocation.[9,16] Dislocations of the shoulder are thought not to be a risk factor for the development of arthrosis, although this has never been proven.[13,18]

Dislocations and recurrent instability of other joints, such as the hip or the metacarpophalangeal joint of the thumb, have been associated with the development of degenerative changes.[2] Traumatic shoulder dislocations are the result of a significant force applied to the glenohumeral joint and generally involve damage to soft tissue including the capsule, labrum, and rotator cuff, as well as bone and cartilage.[21] Therefore, it is possible that dislocation of the glenohumeral joint could contribute to subsequent degenerative disease.

The rate of recurrence after a first-time dislocation varies from 10% to 90%, with younger patients having a greater risk of recurrence.[8,10-13,15,18,20] Dislocation arthropathy has been reported in some patients who sustain recurrent dislocations and in whom arthrosis of the shoulder subsequently develops.[4,19] The goal of this study is to document whether an association exists between shoulder dislocation and the subsequent development of arthrosis and to quantify this association, if present.

## MATERIALS AND METHODS

The patients for this study had to have documented glenohumeral osteoarthrosis, as opposed to avascular necrosis, post-traumatic arthrosis, rheumatoid arthritis, or cuff tear arthropathy. Such a group is difficult to define for several reasons. It is difficult to arrive at objective criteria to define arthrosis. If arthrosis is present, it is difficult to know that another pathologic entity is not responsible for the pain and disability. Lastly, there is a wide range of severity of glenohumeral arthrosis.

We elected to use patients with osteoarthrosis who had undergone hemi-shoulder or total shoulder arthroplasty (TSA) as cases for this study for 3 reasons. All patients had severe, symptomatic arthrosis requiring surgical intervention, the diagnosis was confirmed at surgery, and this sample of patients was easily identifiable.

The exposure was glenohumeral dislocation. The case patients were mailed a brief survey asking if they had ever sustained a shoulder dislocation. Only those who required reduction were included to ensure that the patients had

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**Table I** History of dislocation in cases and control subjects (including patients who had shoulder surgery prior to TSA)

| | History of dislocation | No history of dislocation |
|---|---|---|
| Patients with shoulder arthrosis who had TSA | 11 | 80 |
| Patients without shoulder arthrosis | 2 | 280 |

OR, 19.3 (95% CI, 4.0-180.5).
$P = .000006$, Fisher exact test (2-tailed).

indeed sustained a true dislocation. Recollection bias is often a concern in case-control studies. However, it is highly unlikely that anyone who had dislocated his or her shoulder and required a reduction at any time would forget such an experience. All patients who stated that they had a dislocation were contacted by phone to verify that it was indeed a dislocation requiring reduction, as well as to gain additional information (date of the dislocation, mechanism of injury, number of recurrences, and whether they had surgery prior to TSA).

The control subjects had to be similar to the case patients with respect to all relevant variables, except the exposure. We selected patients who had undergone total knee arthroplasty for arthrosis because they are of similar age, health, and mental status as those undergoing TSA for arthrosis. In addition, they are easy to locate and were believed likely to return the survey. We mailed the control subjects a 4-question survey asking the following:

1. Do you have pain or difficulty moving your shoulder?
2. Do you have trouble with your usual daily activities because of stiffness or discomfort in your shoulder?
3. Have you had any previous surgery on, or injections in, your shoulder?
4. Have you ever dislocated your shoulder?

Patients were excluded if they answered "yes" to any of the first 3 questions because of the possibility that they may have had arthrosis. Although many patients may have been excluded despite not having a true disorder of the shoulder, we were certain not to have included patients with clinically relevant arthrosis. Control subjects were matched for sex, side, and age (within 5 years). We did not control for hand dominance because this variable is not associated with the side of dislocation.[11,18]

The study may be biased if another variable exists that is associated with both the exposure and the outcome.[1] Such a variable is termed a confounder.[1] The surgical stabilization of patients with recurrent dislocations has been associated with the development of arthrosis if the repair causes a significant limitation of rotation[7,14] or if hardware penetrates the joint.[24] The data were analyzed with and without patients who had previous surgery to avoid the potentially confounding effect of this variable.

A maximum dislocation rate of 2% was expected in the control subjects based on previous epidemiologic research.[9,20] A rate of dislocation 4 times greater was considered to be clinically significant. Therefore, we estimated the rate of dislocation among cases at 8%. For 100 cases, we required 200 control subjects for a 2-tailed test with an alpha of .05 and a beta of .20. Alpha (or type I) error is the chance that the investigator will incorrectly conclude that there is a difference when, in fact, none exists. Beta (or type II) error is the chance that the investigator will incorrectly conclude that there is no difference when, in fact, one exists.

We performed both matched and overall analyses. The overall analysis included all cases and control subjects. Control subjects were matched for age, side, and sex. We attempted to find 2 control subjects per case for the matched analysis and, therefore, mailed questionnaires to 8 potential control subjects per case. All eligible control subjects were used for the overall analysis. For the matched analysis, the order of which control subjects to include, if more than 2 per case were eligible, was determined a priori, and if there were more than 2, we used only the first 2. The odds ratio (OR), with 95% confidence intervals (CIs), was determined. The Fisher exact test was used to determine the statistical significance of the relationship. The McNemar test was used to determine the statistical significance in the matched analysis.

## RESULTS

Of 133 patients, 91 who underwent TSA for arthrosis in the past 10 years responded to the questionnaire. The mean age was 70.0 years (range, 46-88 years). Thirty-three patients were women, and 58 were men. Fifty-nine had a right TSA, and 32 a left TSA. Eleven patients had sustained traumatic dislocations of the same shoulder prior to TSA. Five of these patients had a previous surgical procedure, whereas 6 did not have surgery prior to TSA. Of the patients who had surgery prior to TSA, 3 felt their motion was significantly decreased after the first procedure. However, we were unable to confirm what type of procedure was performed (ie, anterior stabilization or other).

Of the 6 patients who had previous traumatic dislocations and no surgery prior to TSA, 2 had only a single dislocation. One was a 70-year-old man who had his dislocation at age 45 years, and the other was a 75-year-old woman who had her dislocation at age 42 years. The other four all had multiple dislocations (range, 30 to >100), with the initial dislocation occurring between the ages of 14 and 19 years in all 4 patients.

Seven hundred twenty-eight patients who underwent total knee arthroplasty (8 per case) were sent questionnaires. Four hundred three responded. One hundred twenty-one patients were excluded for answering questions that indicated that they possibly had arthritis. Of these, 22 answered positively to question 1 only, 4 to question 2 only, 16 to question 3 only, 50 to questions 1 and 2 only, 7 to questions 1 and 3 only, 1 to questions 2 and 3 only, and 21 to all 3 questions. This left 282 control subjects for study. Their mean age was 70.2 years (range, 46-89 years). There were 194 men and 88 women. One hundred sixty-three patients were asked about their right side, whereas 119 were asked about the left side based on their matched case. Only 2 patients had traumatic dislocations of the shoulder, and in both

**Table II** History of dislocation in cases and control subjects (excluding patients who had shoulder surgery prior to TSA)

| | History of dislocation | No history of dislocation |
|---|---|---|
| Patients with shoulder arthrosis who had TSA | 6 | 80 |
| Patients without shoulder arthrosis | 2 | 280 |

OR, 10.5 (95% CI, 1.8-107.0).
$P$ = .003, Fisher exact test (2-tailed).

**Table III** History of dislocation in cases and control subjects (including only patients who had recurrent dislocations and excluding patients who had shoulder surgery prior to TSA)

| | History of dislocation | No history of dislocation |
|---|---|---|
| Patients with shoulder arthrosis who had TSA | 4 | 82 |
| Patients without shoulder arthrosis | 0 | 282 |

OR, ∞ (95% CI, 2.2-∞).
$P$ = .003, Fisher exact test (2-tailed).

cases the patient did not have a recurrence. None of the control patients had contralateral dislocations.

For the overall analysis (including all cases and control subjects), the OR was 19.3. This indicates that the risk of developing arthrosis of the shoulder requiring TSA was 19.3 times greater in patients who had sustained a previous dislocation compared with control subjects who had never dislocated their shoulder (Table I). This relationship was highly statistically significant, as the 95% CI for the OR did not include 1 and $P$ = .000006. Of the 11 patients with dislocations, 5 had surgery prior to TSA. It is impossible to know whether this surgery was related to the development of arthrosis in these individuals; however, to avoid this potentially confounding variable, we analyzed the data with these 5 patients excluded (Table II). The OR was 10.5, and the relationship was again statistically significant. Lastly, we analyzed the data excluding patients who had not had a recurrence. The relationship between dislocations of the shoulder and arthrosis remained statistically significant (Table III).

For the matched analysis (including only cases with matched control subjects), not including patients who underwent surgery prior to TSA, there were 162 matched pairs. Among the cases, there were 11 patients who had dislocated their shoulder (certain patients were counted twice if 2 matching control subjects were available). Both patients in the control group with a history of dislocation were matched successfully and were included in this analysis. Shoulder dislocations were associated with arthrosis requiring TSA in this analysis as well ($P$ = .02).

## DISCUSSION

It is practically very difficult to assess prospectively whether there is an association between dislocations of the shoulder and the development of arthrosis.[4] Most patients are young, and long-term patient tracking with longitudinal follow-up over several decades is difficult.[4]

A case-control study is research that begins at the end, rather than at the beginning, of the causal pathway.[5,22] This methodology is useful for studies of rare diseases or conditions such as shoulder arthrosis. The investigator must find similar patients with and without the condition in question and subsequently quantify the exposure of each group to the potentially causative factor (ie, shoulder dislocation). The risk of developing the condition by being exposed to the factor can then be calculated. The main advantages of case-control studies are that the investigator is able to answer the question in a short time frame and the study is relatively inexpensive to carry out. For these reasons, case-control methodology lends itself to the question that is the subject of this study.

In this case-control study, a statistically significant relationship was demonstrated between dislocations of the shoulder and the subsequent development of arthrosis requiring TSA. The development of arthrosis warranting TSA was 20 times more common in patients who had sustained a previous dislocation. When patients who had surgery prior to TSA were excluded (to avoid the possibility of including patients with iatrogenic arthrosis), degenerative disease was 10 times more common in shoulders that had been dislocated. However, it remains unknown whether the arthrosis in these patients who had surgery prior to TSA would have occurred if they had not had that prior procedure. Both analyses were robust, as the 95% CIs for the ORs did not include 1. Therefore the true OR is probably at least 10, but no greater than 20.

Arthrosis of the shoulder is a relatively uncommon condition. Therefore, if the rate of arthrosis among patients who dislocate was 10 to 20 times greater, the effect on the overall population would be relatively minor. This is because arthrosis would still be quite rare in patients who dislocate, and they only account for approximately 1% of the population.

Recurrent episodes of dislocation can lead to repetitive chondral injury, which may cause joint degeneration.[4,19] Similarly, a single shoulder dislocation may lead to an initial cartilage or soft tissue injury, which can place the patient at risk for future arthrosis. However, the number of recurrent dislocations has not been shown to correlate with arthrosis.[19] A similar trend was seen in this study because our analyses, including both those with a one-time dislocation and those with recurrent dislocations, demonstrated an increased risk of arthrosis in these individuals.

Only patients with severe glenohumeral arthrosis requiring TSA were included. Those with arthrosis of the shoulder not severe enough to require TSA were not captured. Therefore the results are only able to be generalized to severe arthrosis requiring TSA. However, if a patient has mild glenohumeral disease that does not require TSA, the clinical significance of his or her shoulder condition is less important. Similarly, patients who sustained subluxations or dislocations that did not require reduction were not included. Therefore the results of this study are only applicable to patients who have sustained a dislocation that required reduction.

This study did not attempt to assess the direction of the dislocation because in most cases it had occurred many years earlier. Anterior dislocations of the shoulder are approximately 20 to 80 times more common than posterior dislocations.[18,23] Although it is likely that the majority of dislocations in this study were anterior, we do not know this with certainty.

This study had several limitations. Although we matched for several important variables, it was impossible to match for previous activity level. If the activity level was significantly different between the 2 groups, then the study could be biased. However, it is unlikely that a difference in activity level between the 2 groups was responsible for the findings of this study.

Each control subject was asked 3 detailed questions regarding the medical and surgical history of his or her shoulder. This allowed the exclusion of patients with arthrosis from the control group to avoid detection bias. It is possible that a control patient may have had very early arthrosis that was not detected by our 3 questions. However, a patient who is able to answer negatively to all 3 questions does not have a clinically important shoulder pathologic condition.

The number of patients with a history of shoulder dislocation in our group undergoing TSA is significant when compared with age- and sex-matched control subjects. Previous investigators have also noted many patients with a history of instability among patients undergoing TSA. Gartsman et al[6] reported that 6 of 83 (7.2%) patients undergoing TSA had a history of instability. Of 273 patients, 26 undergoing total or hemiarthroplasty in the series of Neer et al[17] had a history of instability, although the majority had surgery prior to TSA. Bigliani et al[3] reported on 17 patients with a history of instability surgery who underwent TSA at their institution over a 7-year period.

In the prospective study by Hovelius et al[11] of first-time anterior shoulder dislocations in patients aged 40 years or younger, 11% of patients had radiographic evidence of mild arthrosis and 9% had radiographic evidence of moderate to severe arthrosis at 10 years. As in the study of Samilson and Prieto,[19] some of the shoulders with arthrosis in their series had not had a recurrence.

Glenohumeral dislocation was found to be associated with a 10- to 20-fold increase in the risk for the subsequent development of arthrosis. Severe arthrosis of the shoulder is uncommon, and a 10- to 20-fold increase in the incidence among patients who sustain a dislocation would not make this condition widespread. Nevertheless, this association has not been reported previously. In light of this study, further research into the natural history of patients with dislocations of the glenohumeral joint is warranted.

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