# Clinical Article

# The importance of the sagittal position of the arm in the measurement of external rotation of the adducted shoulder

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## Abstract

The measurement of external rotation of the shoulder is commonly performed in two ways: with the arm adducted or with the arm abducted to 90°. This measurement forms an important part of the assessment of shoulder function.

It has been shown that the observer reliability of external rotation measurement is poor.[1-4] Following the observation that the range of external rotation of the shoulder with the arm adducted altered depending on the exact position of the arm in the sagittal plane, we conducted a study to quantify the effect of a small increment of forward flexion (15°) on the range of external rotation.

External rotation of the shoulder was measured in 40 asymptomatic shoulders and 20 'frozen' shoulders with the arm in a vertical position and in 15° of forward flexion. The range of external rotation decreased significantly in forward flexion in both groups. External rotation decreased by an average of 16.9° in the asymptomatic group and 13.5° in the frozen shoulder group.

This study has shown that the sagittal position of the arm has an effect on the range of external rotation of the adducted shoulder. This may account for some of the observer variation in its measurement and affect the scores of certain outcome measures.

## Introduction

The measurement of external rotation forms an integral part of the assessment of shoulder function. It has particular significance in the assessment of particular shoulder conditions and the outcome of certain procedures such as frozen shoulder and arthroscopic capsulotomy.

**The sagittal position of the arm has an effect on the range of external rotation of the adducted shoulder**

**Table I**

| | Asymptomatic | | | Frozen shoulder | | |
|---|---|---|---|---|---|---|
| | Vertical | 15º flexion | Difference | Vertical | 15º flexion | Difference |
| **Mean** | 59.6 | 42.8 | 16.9 | 22.0 | 8.5 | 13.5 |
| **Median** | 60 | 45 | 15 | 20 | 5 | 15 |
| **Standard deviation** | 11.7 | 10.5 | 4.5 | 8.9 | 8.0 | 3.3 |

The measurement of external rotation of the shoulder is commonly performed in two ways: with the arm adducted or with the arm abducted to 90°. It had been observed by the senior author that external rotation of the shoulder with the arm adducted altered significantly depending on the exact position of the arm in the sagittal plane. A study was therefore undertaken to evaluate the magnitude of this difference.

## Materials and methods

Two cohorts of subjects were investigated. Forty subjects with asymptomatic shoulders were randomly selected, together with a second cohort of 20 subjects with the clinical diagnosis of frozen shoulder.

One of the authors (MGP) performed all of the measurements. The measurements were performed with the subjects sitting against a wall. External rotation was measured using a hand-held goniometer in two positions of shoulder flexion. The first measurements were taken with the arm in a vertical position and the second in a position of 15° forward flexion. The elbow was controlled against the body and the passive range of external rotation was measured.

Range of motion data for each patient was tabulated and analysed. Statistical analysis of the results was performed using Dunn's Multiple Comparisons Test. The critical p-value for significance was taken as 0.05.

## Results

The asymptomatic cohort was made up of 23 males and 17 females, with 24 being dominant limbs. There was no history of previous problems with the shoulder or other part of the study limb. External rotation was significantly reduced ($p<0.05$) in the forward flexed when compared with the vertical position (*Table I*).

The frozen shoulder cohort was made up of 17 females and three males, with 11 being dominant limbs. The average length of symptoms was seven months (range 5-9). Shoulder movements were globally decreased compared with the contralateral shoulder. External rotation was significantly reduced ($p<0.01$) in the forward flexed when compared with the vertical position (*Table I*).

## Discussion

External rotation of the shoulder alters with age and differs between the sexes. There are also differences between dominant and non-dominant limbs.[5] Although clinical observations of range of motion are prone to intra- and inter-observer error,[2-4] they still remain an important part of the functional assessment of the shoulder. External rotation in particular has been reported as having an extremely low inter-observer reliability.[1]

Advanced techniques of measurement using angular velocity vectors have been shown to improve reliability[6] but for the majority of clinicians these techniques are inaccessible. Pearl *et al* attempted to standardise the nomenclature of the description of shoulder movements.[7] This 3-D descriptive model attempted to highlight the pitfalls of describing movements in two planes but has not been widely adopted for the reporting of shoulder function. The scoring of Constant and Murley goes some way to eliminating the need for exact measurements of shoulder movement.[8]

Our study illustrates the intimate relationship between the arm's sagittal position and external rotation of the shoulder. Browne *et al*[9] have previously shown in cadavers that the humerus exhibits obligatory external rotation at the gleno-humeral joint when the joint is placed into a forward flexed position. They describe this as being necessary to allow the tuberosity to clear the acromion and suggest this as a factor in the reduced forward flexion found in adhesive capsulitis.

We postulate that some of the variation in external rotation of the shoulder related to the sagittal position of the arm is a function of scapula positioning. With arm flexion the scapula protracts resulting in alteration in glenoid version. This results in a relative loss of external rotation observed when measured from the neutral position of the arm. If, however, measurements were made relative to the plane of the scapula, then less difference in external rotation would be observed. This would not account for the large differences observed in this study. The remainder is due to alteration in soft tissue tension in the two arm positions.

**Figure 1a: External rotation with humerus vertical and adducted**

**Figure1b: External rotation with humerus in forward flexion and adducted**

**Accurate measurement of external rotation has a significant bearing on the ability to compare procedures for frozen shoulder such as manipulation or arthroscopic capsulotomy**

In this study the amount of forward flexion (15°) chosen could easily be produced unwittingly during examination in the clinic setting. We feel that our observations illustrate the importance of standardising the position of the arm during measurements of this type. Although the differences in rotation (*Figures 1a & 1b*) may not necessarily be of great functional importance they are great enough to affect the scores in certain functional scoring systems. Accurate measurement of external rotation has a significant bearing on the ability to compare procedures for frozen shoulder such as manipulation or arthroscopic capsulotomy. These differences are likely to be increased in studies with more than one observer.

*The content of this article is the sole work of the author. No benefits of any form have been derived from any commercial party related directly or indirectly to the subject of this article.*

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