

Analysis of Rotation Accompanying Shoulder Flexion

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For effective rehabilitation of the shoulder, physical therapists must have correct knowledge of shoulder motion. Reports conflict on whether medial or lateral rotation of the humerus accompanies shoulder flexion. The purpose of this study was to determine the relationship between flexion and rotation at the glenohumeral joint. We determined rotation that accompanied active shoulder flexion by using a universal full-circle goniometer and an adjustable wooden bracket that served as a base for a gravity-activated angle finder. Therapists performed passive shoulder flexion with the humerus held allowing no rotation and then held in medial or lateral rotation. We used single-tailed *t* tests to determine analysis. We found significant differences ($p < .01$) between the amount of shoulder rotation accompanying active shoulder flexion between men and women. Medial rotation of the shoulder accompanied active flexion in all subjects. Physical therapists should consider these results when the goal of treatment is to increase shoulder flexion.

Key Words: *Physical therapy, Shoulder joint, Rehabilitation.*

Whether the humerus rotates medially or laterally during forward elevation of the arm in the sagittal plane is an unanswered question. If the physical therapist is to rehabilitate the shoulder effectively, correct knowledge of shoulder motion is essential. Wells and Luttgens¹ and Moseley² contend that external rotation of the humerus is required to elevate the arm in the sagittal plane. Codman states, "In order for the arm to reach full flexion of the glenohumeral joint, the arm must internally rotate."³ Steindler reports that when the arm is elevating forward, there is forced inward rotation beyond the horizontal caused by ligamentous tension.⁴ De Palma states that if the arm is held in external rotation during elevation in the sagittal plane, it will lock at about 45 degrees above the horizontal and further elevation is impossible; however, internal rotation of the arm to 45 degrees permits it to be raised to complete elevation.⁵ Most literature concerning shoulder motion does not specify either lateral or medial rotation of the hu-

merus with elevation of the arm in the sagittal plane.⁵⁻¹³

The purpose of this study was 1) to determine the amount of active medial or lateral rotation of the humerus that accompanies shoulder flexion and 2) to study the differences in rotation of the humerus between men and women in performing active shoulder flexion.

METHOD

Subjects

The 11 volunteers for the study were 18- to 30-year-old male and female physical therapy students and physical therapists who had no evidence of disease or limitations of the dominant upper extremity.

Procedures and Equipment

After a briefing, which included obtaining informed consent, we tested the subjects. We asked them to lie in a supine position on a treatment table, with their clothing removed from their dominant shoulders and their hips and knees flexed. The subjects performed three trials of active shoulder flexion to the end of range from a starting position in which the upper limb was as close to the trunk as feasible, the cubital fossa faced anteriorly, and the forearm was in mid pronation-supination. Active shoulder flexion trials were followed by passive shoulder flexion trials. For passive flexion, we used three starting positions. We

held the humerus first allowing no rotation, then in lateral rotation, and finally in medial rotation. For all passive tests, the forearm remained in mid pronation-supination. We performed three trials of passive shoulder flexion from each of the different starting positions. In each trial, the arm was passively flexed until the tester could palpate a change in the rotation or until the subject reached the end of shoulder flexion range.

We determined the amount of shoulder flexion in each subject by using a universal full-circle goniometer and techniques of joint measurements as outlined by Moore.¹⁴ We determined the amount of humeral rotation at 90 degrees of active shoulder flexion by using an adjustable wooden bracket aligned to the humeral epicondyles (Figure). The wooden bracket served as a surface for the alignment of the universal goniometer. One arm of the goniometer was aligned to the pointer of the adjustable bracket, which represented an axis through the humeral epicondyles, and the other arm was aligned with a wooden surface that was perpendicular to the motion. We determined the type of rotation by the direction of the pointer on the adjustable wooden bracket.

We determined the amount of humeral rotation at the end of range during active shoulder flexion and at the starting positions of passive flexion by using a gravity-activated angle finder with its

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TABLE 1
Shoulder Flexion and Accompanying Medial Rotation^a During Active Range of Motion (N = 11)

Position	90° Flexion			End Flexion		
	\bar{X}	s	Range	\bar{X}	s	Range
Shoulder flexion	90	0	0	170.9	6.0	162-180
Accompanying medial rotation	47.2	9.4	30-63	94.9	13.5	52-114

^a Measured in degrees.

base resting on the surface of the adjustable wooden bracket placed over the humeral epicondyles of the dominant upper limb (Figure). The angle finder was specified to be accurate by ± 1 degree.

Data Analysis

We recorded the amount of flexion and rotation for each trial and computed descriptive statistics for the means, standard deviations, and ranges for the three trials of each motion. We used the mean of the three trials of each motion in calculating a group mean. We used a single-tailed *t* test to determine differences between the amount of rotation accompanying active flexion of men and women and between the amount of flexion obtained.

Results

Medial rotation of the shoulder accompanied active flexion in all 11 subjects. The means, standard deviations, and ranges of shoulder flexion and associated medial rotation during active range of motion (ROM) are summarized in Table 1. Table 2 shows the results of the descriptive statistics for shoulder flexion during passive ROM from the three different starting positions. The amount of rotation remained unchanged throughout the motion when passive flexion was performed with the humerus held in medial rotation. Analysis of active shoulder flexion

TABLE 2
Shoulder Flexion^a During Passive Range of Motion with Humerus in Three Different Starting Positions (N = 11)

Starting Position	\bar{X}	s	Range
No rotation	42.4	8.5	31-58
Lateral rotation	30.2	6.5	21-43
Medial rotation	169.5	8.7	156-180

^a Measured in degrees.

and associated medial rotation showed a significant difference ($t = 3.86$, $p < .01$) between men and women (Tab. 3). No significant difference appeared in the amount of shoulder flexion between men and women in passive flexion.

DISCUSSION

The results of this study support the conclusions of Codman,³ Steindler,⁴ and

De Palma⁵ that medial rotation of the humerus accompanies shoulder flexion. Most textbooks agree the anterior fibers of the deltoid muscle, clavicular fibers of the pectoralis major muscle, and both heads of the biceps brachii muscle are shoulder flexors. Anatomy and kinesiology experts agree that the anterior fibers of the deltoid and the clavicular head of the pectoralis major are medial rotators of the humerus; the same muscles that cause flexion at the glenohumeral joint also cause medial rotation.^{6,15}

The finding that all subjects actively medially rotated at the shoulder joint during elevation of the humerus in the sagittal plane is valuable to clinicians and instructors. When evaluating patients with decreased flexion range, they should evaluate medial rotation of the shoulder as an accompanying motion, just as they evaluate lateral rotation with abduction of the shoulder. When thera-

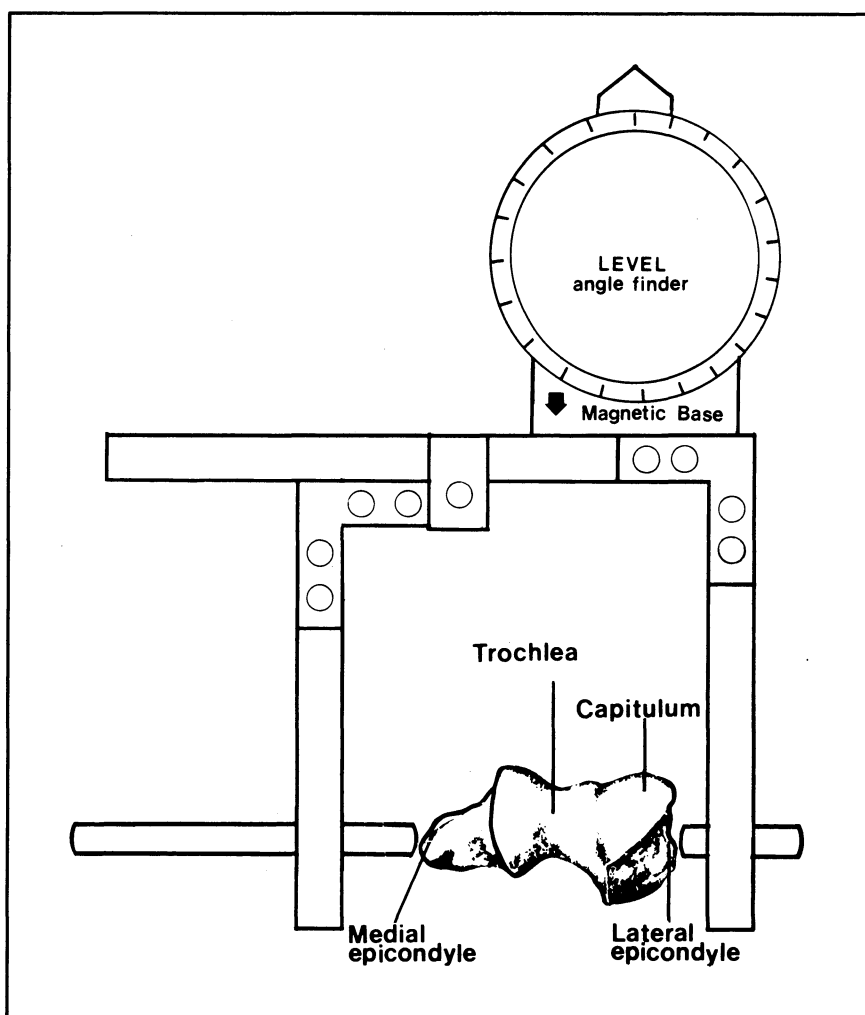


Figure. Adjustable wooden bracket and angle finder used for measuring rotation of the glenohumeral joint aligned with the distal aspect of the humerus.

pists wish to increase active or passive flexion motion, methods to ensure accompanying medial rotation may help them achieve treatment goals. When we performed passive ROM on men and women during this study, the amount of flexion was equal; however, the degrees of motion in medial rotation were greater in women.

Our finding has cast some doubt on the previous concepts of the motion occurring at the glenohumeral joint using the widely accepted diagonal patterns to increase range, strength, or coordination. Additional research needs to be performed to determine the natural rotational component of the shoulder when diagonal flexion patterns are performed in combination with abduction and adduction.

CONCLUSION

The results of this study suggest that medial rotation accompanies active and passive shoulder flexion. A significant difference exists between men and women in the amount of medial rotation accompanying active shoulder flexion. Physical therapists should consider these results when the goal of treatment is to increase shoulder flexion.

TABLE 3
Shoulder Flexion and Accompanying Medial Rotation* During Active Range of Motion Between Men and Women (N = 11)

Position	Men			Women		
	\bar{X}	s	Range	\bar{X}	s	Range
Shoulder flexion	170.3	7.9	162-180	171.4	3.7	168-177
Accompanying medial rotation	75.9	19.7	52-106	110.6	3.2	104-114

* Measured in degrees.

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