

HANDEDNESS INFLUENCES PASSIVE SHOULDER RANGE OF MOTION IN NONATHLETE ADULT WOMEN

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ABSTRACT

Objective: The purpose of this study was to determine whether handedness influences bilateral shoulder range of motion in nonathlete adult women.

Methods: This was an observational study. Shoulder range of motion (flexion, abduction, horizontal adduction, extension, external and internal rotation) was passively and bilaterally measured in 50 female, right-handed, and healthy university students, ranging from 20 to 29 years of age, who were not practicing repetitive activities with the upper limbs at the time of this study. The assessment was performed with a universal goniometer, twice for each subject by the same examiner. The first and second measurements were correlated using the intraclass correlation coefficient, which was high for all movements and ranged from 0.80 to 0.97. The Student *t* test and Wilcoxon test were used to compare the range of motion between the dominant and nondominant shoulders and the mean differences between the 2 sides. The effect of size was $\alpha = .05$.

Results: There is statistically significance difference between the 2 sides when the rotational range of motion is compared; the dominant shoulder presented increased external rotation (mean, 4.74°; 95% confidence interval, 1.61-7.87) and decreased internal rotation (mean, 3.52°; 95% confidence interval, 1.64-5.4) compared to the opposite shoulder.

Conclusion: Dominance should be considered when shoulder rotation is evaluated even in nonathlete adult women. (J Manipulative Physiol Ther 2009;32:149-153)

Key Indexing Terms: *Range of Motion; Shoulder Joint; Functional Laterality; Physical Therapy*

The clinical measurement of joint range of motion (ROM) is an important issue in a musculoskeletal examination,¹⁻³ essential in the planning of phy-

siotherapy and to determine effectiveness of therapeutic intervention.^{1,3-5} A factor that might affect upper extremity ROM is handedness, which is defined by the individual's preference to use 1 hand predominantly for unimanual tasks.⁶

Goniometry is the most widely used ROM evaluation procedure,^{2,7} especially when performed with the universal goniometer.^{5,7-10} This instrument is considered to be a valid clinical tool⁵ and shows excellent reliability in the assessment of upper extremity active^{11,12} and passive ROM,^{3,10} including shoulder measurements.¹⁰⁻¹²

Several reports verified adaptation on flexibility and shoulder rotational ROM in diverse professional overhead athletes (basketball, volleyball, tennis, handball, and baseball players). Significant differences on active and passive ROM was found between the sides: The dominant shoulder had decreased internal rotation and increased external rotation.^{2,13-17}

However, there are few studies about the influence of handedness on the shoulder ROM of nonathlete subjects, especially women. Some of these reports found no significant differences between the measurements of the 2 sides or attributed any differences to chance.^{8,11} These studies stated that the joint motions of the healthy extremity can be routinely used to compare with those of the contralateral and affected side.^{5,8} Others, otherwise, showed decreased passive and active ROMs on the dominant shoulder in military recruits,⁹ increased active internal rotation and extension

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Table 1. Intrarater reliability (95% CI) for the passive bilateral shoulder ROM

Movement	Intraclass correlate coefficient	
	Right (95% CI)	Left (95% CI)
Flexion	0.84 (0.72-0.91)	0.94 (0.89-0.96)
Horizontal adduction	0.86 (0.75-0.92)	0.86 (0.75-0.92)
Abduction	0.81 (0.66-0.89)	0.80 (0.64-0.88)
Extension	0.83 (0.69-0.90)	0.87 (0.77-0.93)
Internal rotation	0.96 (0.93-0.98)	0.92 (0.86-0.95)
External rotation	0.97 (0.94-0.98)	0.92 (0.86-0.95)

ROM on the nondominant shoulder,⁸ and increased active and passive external rotation ROM and less internal rotation ROM for the dominant shoulder⁴ in men and women of different ages.

The unaffected extremity of the patients (nondominant extremity in healthy individuals following preventive programs) serves as a base for the determination of the normal ROM; even a small difference in joint movement might be important in patient evaluation. Therefore, knowledge of the normal bilateral shoulder ROM pattern is essential and can determine the loss in ROM after glenohumeral joint injury and provide the perspective for a good rehabilitation program.² The purpose of this study was to measure the passive bilateral shoulder ROM in healthy adult women to determine whether it is influenced by handedness.

METHOD

Participants

Fifty white female students, ranging from 20 to 29 years of age, were assessed by a physiotherapy student in this study. They all had a normal body mass index (BMI; $20 < \text{BMI} < 24$, 9),¹⁸ and they were all right-handed according to a questionnaire adapted from the Edinburgh inventory.¹⁹ The exclusion criteria were hypermobility, previous surgery, trauma or injury involving any joint of either of the upper extremities, painful ROM, and pregnancy. Instrumental musicians, dancers, and subjects who used their upper extremities in repetitive activities—like overhead sports involving repeated, preferentially unilateral, forceful arm actions—were also excluded from the study. Before the procedure, the subjects filled in a brief personal history questionnaire and signed a written informed consent form. This study was approved by the Review Board for Human and Animal Studies, CAPPesq—Hospital das Clínicas, School of Medicine, University of Sao Paulo (Ethics protocol reference number 786/05). Fundação de Amparo a Pesquisa do Estado de São Paulo provided financial support for this study.

Outcome Measures

A plastic standard universal goniometer (Carci, São Paulo, Brazil) was used, with scales marked in 1°

Table 2. Mean (SD) characteristics of the subjects

Characteristics	Mean \pm SD	Range
Age (y)	22.5 \pm 2	20-27
Weight (kg)	58 \pm 7.3	46-79
Height (m)	1.64 \pm 0.1	1.49-1.80
BMI (kg/m ²)	21.67 \pm 1.7	20-24.8

increments. Spherical bone landmarks, a stretcher, tape measure, and a Wind MEA 07700 digital balance were also used.

The measurement techniques followed those of Palmer and Epler.²⁰ The participants were tested in a position with good corporal alignment and stabilization and with the arm uncovered to facilitate movement and for the identification of bone references. An explanation of the measurement procedure was given, and using standard goniometer techniques, the examiner measured passive flexion, horizontal adduction, abduction (sitting position), extension (prone position), and external and internal rotation (supine position) at 90° of abduction. Glenohumeral internal rotation was measured without scapular protraction, until the scapula visually began to lift from the examination table surface,¹ to provide a pure glenohumeral joint movement. The testing order of the dominant and nondominant shoulders was randomly determined, and all measurements were first taken on 1 side of the body and then on the contralateral side. All ROM measurements were registered in degrees, and neither the examiner nor the participants were blinded to the goniometric results during measurement. The same examiner made the measurements twice for each subject within a 2-week period. To verify intrarater reliability, we calculated the intraclass correlation coefficient with SPSS Statistics version 10 (SPSS Inc, Chicago) to indicate the level of agreement between the ranges of the first and second measurements for each motion. Intraclass correlation coefficient values ranged from 0.80 to 0.97, indicating good to excellent intrarater reliability (Table 1).²¹

Data Analysis

Descriptive statistics were calculated with the Microsoft Office Excel version 11.0 (Microsoft, Washington). After applying the Shapiro-Wilk normality test, the Student *t* test and Wilcoxon test were analyzed with StatSoft Statistica 6.0 (StatSoft Inc, Tulsa) to compare the ROM between the dominant and nondominant shoulders, and the mean difference between the 2 sides, with confidence intervals (CIs). The effect of size was $\alpha = .05$.

RESULTS

The physical characteristics of the subjects who took part in this study are shown in Table 2. The Beighton Score²² ranged from 0 to 2 points, showing no hypermobility in any

Table 3. Mean (SD) of the ROM measurements for the right and left shoulders and mean (95% CI) difference between the 2 sides

Movements	Right	Left	Difference	P
	Mean \pm SD ($^{\circ}$)	Mean \pm SD ($^{\circ}$)	Mean (95%CI)	
Flexion	167.1 \pm 7.5	167.5 \pm 7.0	-0.52 (-1.72 to 0.68)	.61
Horizontal adduction	37.6 \pm 5.5	37.1 \pm 7.0	0.22 (-1.47 to 1.91)	.55
Abduction	171.2 \pm 5.4	171.5 \pm 5.1	-0.1 (-1.63 to 1.43)	.7
Extension	39.3 \pm 7.9	39.3 \pm 8.6	0.52 (-0.79 to 1.83)	.83
Internal rotation	58.5 \pm 10.5	62.0 \pm 10.4	-3.52 (-5.4 to -1.64)	<.001
External rotation	114.8 \pm 12.9	109.7 \pm 11.9	4.74 (1.61 to 7.87)	.003

subject. Table 3 shows the mean values for the goniometric measurements and the standard deviations, and a comparison between shoulder ROM for the right and left sides. No statistical significance between the extremities was found for flexion, horizontal adduction, abduction, and extension. However, the dominant shoulder presented significantly decreased ROM for internal rotation (3.52 $^{\circ}$; 95% CI, 1.64-5.4) and increased ROM for external rotation (4.74 $^{\circ}$; 95% CI, 1.61-7.87).

DISCUSSION

Similar results for the influence of dominance on rotational shoulder ROM were found in studies with female and male overhead athletes.^{2,13,14,16,17} Stressing and repetitive activities, with unilateral overload of upper extremities, can lead to physiological tissue adaptation, stretching of the anterior capsule,^{17,23} fibrosis tissue formation in the posterior capsule,^{16,17} and musculotendinous tightness in the posterior rotator cuff on the dominant side.^{13,16} These alterations in joint flexibility may be necessary for optimal throwing performance, as faster throwing speed.²³

These differences have also been reported in healthy nonathletes and in nonoverhead athletes. Sauers et al²⁴ found decreased values for shoulder internal rotation and extension and increased values for external rotation on the dominant side. A group of healthy, right-handed male subjects, ranging from 8 months to 54 years old, presented increased active shoulder internal rotation and extension on the left side. However, the authors concluded that the left and right joint amplitudes were consistently similar.⁸ Barnes et al⁴ evaluated healthy men and women, from 4 to 70 years old, mostly right-handed. The subjects showed increased values for active and passive shoulder external rotation with the dominant arm and decreased internal rotation. Because young subjects also presented significant differences, the authors stated that repetitive microtraumas could not be the only cause of this discrepancy, as one might imagine if considering only athletes. However, dominance has a different effect in nonathletes as compared to athletes who practice sports activities with an emphasis on excessive asymmetry.²⁵ There is no difference in glenohumeral joint laxity between the shoulders nor correlations between laxity and passive shoulder ROM.²⁴

External rotation is widely used for basic daily activities. Joint stability is necessary²⁵ because external rotation is unstable in extreme ranges, especially in abduction. Passive components, in combination with muscle length and strength and coordinated muscle contractions, especially of the rotator cuff,^{23,25,26} are needed. Although the agonist acts concentrically, the antagonists eccentrically control the movement in an effort to prevent articular overloading and to dynamically stabilize the joint,²⁷ minimizing the risk of injury. The internal rotators are more potent in controlling external rotator activity than the inverse.²⁵ It is probable that the excessive use of the dominant limb reinforces this pattern, making the internal rotators more efficient than the contralateral ones, allowing more stability for external rotation in wider ranges of this limb.

Changes occur in muscle submitted to more frequent and intensive daily use.²⁸ Consequently, there is greater internal rotator force of the dominant shoulder in healthy subjects.^{29,30} Ligament and conjunctive tissue hypertrophy and greater structural and functional tendon and ligament integrity also occur.²⁸

The periscapular muscles also create stability at the shoulder and positioning of the scapula. The nondominant system is specialized in maintaining a stable limb position or posture.³¹ During this positioning, the nondominant limb usually maintains scapular retraction. This practice may result in more active scapular retractor muscles on the nondominant side, resulting in an earlier scapular protraction of the dominant limb and, consequently (according to the method of measurement), a decreased internal rotation ROM on this side, as found in the present study.

The changes are possibly a consequence of different activity levels between the limbs because functional movements lead to tissue adaptations.²⁶ Functional asymmetry is, consequently, apparent in the passive ROM measurements, which give exact information about the muscle, ligament, and capsule extensibilities. The advantages of the dominant limb do not apply to all movements. The specificity of the asymmetry can be due to the importance of the rotator cuff in the stability pattern of shoulder stabilization.

In comparison to athletes, the population of this study showed less differences in rotational ROM between the shoulders. In 1 study with young baseball players, differences in rotational motion between the dominant and nondominant shoulders grew larger as the age of the group

increased.¹⁵ For the youngest athletes, the difference between the shoulder rotational ROM was very similar to the difference found in the present study. Even when the asymmetric use of the upper extremities is not as intensive as it is in athletes, there is a small difference between shoulders. This pattern may be intensified with unilateral, stressing overhead activities. It is important to note that although a significant difference, the amount of side-to-side difference of the rotational ROM might not have clinical or functional relevance because it is too small and it is also within the accepted error of goniometric measurement of 5°³²⁻³⁵ and could be attributed to measurement error.³⁶

Limitations

This study contains a few limitations. The population studied was relatively small and very specific, making difficult the extrapolation to other populations. In addition, goniometry only measures in the static range, and the total shoulder ROM involves a relationship between the glenohumeral and scapulothoracic joints, and it is only one of the aspects of a functional evaluation. Further research is thus necessary, using larger populations and other assessments.

CONCLUSION

The clinical implications and functional significance of the small difference found in this study remains to be elucidated. Therefore, passive bilateral shoulder ROM in healthy adult women is influenced by handedness, and dominance must be considered also in nonathlete subjects when shoulder rotation is evaluated.

Practical Applications

- A factor that might affect upper extremity ROM is handedness.
- Small differences in the degrees of joint movement may have clinical implications and can be important in patient assessment.
- Dominance should be considered when shoulder rotation is evaluated in nonathlete adult women.

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