

SHORT ARTICLE

# A new Isokinetic positioning for shoulder test in functional scapular plane

## *Un nuevo posicionamiento para evaluación isocinética del hombro en plano escapular funcional*

 Pavel Loeza Magaña<sup>1</sup>,  Ana Belén Aguilar Valencia<sup>2</sup>,  María Rosa Ramos Cuevas<sup>3</sup>

### ABSTRACT

In this article, we present a positioning proposal to perform an isokinetic shoulder test in the scapular plane, allowing patients with shoulder dysfunction to perform a test and training of reeducation of the biomechanics of the muscles involved, also allowing greater functional movement, more in line with those made in daily life; and the biomechanical bases that justify this position are explained.

**Keyword.** Shoulder, Strength, dynamometry.



### RESUMEN

En este artículo presentamos una propuesta de posicionamiento para realizar una prueba isocinética del hombro en el plano escapular, que permite hacer a los pacientes con disfunción de hombro una prueba y un entrenamiento de reeducación de la biomecánica de los músculos involucrados, y que además facilita un mayor movimiento funcional, más acorde con el que se hace en la vida diaria; y también explicamos las bases biomecánicas que justifican dicha posición.

**Palabras clave.** Hombro, fuerza, dinamómetro.



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The authors declare that there is no conflict of interests.

### INTRODUCTION

The shoulder joint has the largest range of motion because it consists of a small fovea and an unstable humeral head; and the scapular movements are interdependent of the glenohumeral joints, so the movement of both structures must be considered<sup>1</sup>. The isokinetic assessment of the shoulder's movement in the sagittal plane (Flexion - extension) is carried out in a traditional manner, positioning the subject in a supine position and establishing a range of mobility from the extension in neutral position and seeking to reach 160° of flexion. This movement in the pure plane requires a stabilization of the trunk in the

suggested position because a shoulder movement is not only performed with the desired muscle, but it also activates the scapular stabilization which causes compensatory movements in the thorax in detriment of the functional movement or off being a motor movement used in some activity. Besides, flexion beyond 90° becomes biomechanically unstable for the glenohumeral joint. So far, there is no accepted consensus about which movement is optimal for assessing the shoulder<sup>2</sup>, however, most of the functional activities of the shoulder are not performed in the sagittal plane<sup>3</sup>. In this plane, the anatomical marks to align the axes of the shoulder are not easily discernible and the lack of a standard procedure,

results in a large number of incompatible positions. The perfect alignment with the center of instantaneous rotation cannot be guaranteed resulting in a deficiency due to a great modification in the proximal components (scapula, articulation, etc.) during the movement in the sagittal plane, up to 8 cm of variation<sup>2,3</sup>. The isokinetic measurements in the scapular plane have been made in internal and external rotation, in addition, the isokinetic dynamometry is monoaxial, and other components of the torque are dismissed. The reaction forces are not purely tangential to the direction of movement, but also radial, so it is important to align the machine to the axis of the joint to avoid torque discrepancies<sup>4</sup>.

Stability will be achieved by ensuring that the scapula and shoulder respond effectively to the loads<sup>1,2</sup>. The participation of the supraspinatus as a coaptator of the humeral head is balanced with the inferior tractors: infraspinatus, minor round and subscapular muscles; all together stabilize against the ascending forces directed by the deltoid muscle<sup>3,4,5</sup>, this requires intermuscular coordination, and little participation of the passive elements; finally, the glenohumeral stability is due mainly to the muscular control that originates a force of reaction against the glenoid surface<sup>5</sup>.

The current goal is to propose a new positioning model to evaluate the flexion and extension of the shoulder in a more functional model with scapular stabilization.

## POSITIONING PROPOSAL

Isokinetics facilitates the evaluation, treatment and improvement of an individual, so in certain activities that demand high mobility of the shoulder, the application of isokinetics becomes imperative<sup>3</sup>. The reproducibility of isokinetic tests in the scapular plane has an intraclass correlation of 0.87, 0.82, and 0.70 to 60, 180, and 300°/s; the reported ratios are 80% in flexion/extension<sup>3,5</sup>. The proposed model is developed with a Con - Trex ® MJ

equipment (Schnaittach, Germany), with the following parameters: seat at 80° inclination, enough seat length to reach up to 2 cm of the popliteal gap, dynamometer with inclination of 45°, rotation of the dynamometer 30°, height of the dynamometer to maintain the center of rotation at maximum 8 cm of the axillary hollow; alignment of the dynamometer tube behind the middle axillary line ensuring that the center of the dynamometer is aligned with the axillary hollow, the length of the arm attachment is sufficient so that at a 90° flexion the hand remains grasped and the elbow extended. The anatomical position will be the maximum allowed extension which will reach -20° from the 0° position; the flexion will be made up to 160°. The suggested assessment will be made at 90°/s 6 - 10 repetitions 2 series and 180°/s 2 sets of 10 repetitions (test - retest). **Figure 1.**

## BIOMECHANICAL BASIS

The glenohumeral cavity is positioned taking as reference a horizontal line drawn from the back of the thorax in the transverse plane with an angulation of 30° towards anterior, rotation towards anterior 20° and with an inclination towards superior of 10° in the coronal plane. This means that the movements of the shoulder in flexion - extension and abduction - adduction during daily activities are not performed in a pure plane but in a scapular plane, oriented 30° anteriorly from the same horizontal posterior line in the transverse plane<sup>5</sup>.

During a functional movement of flexion - extension in the scapular plane the bicipital slider behaves like a simple pulley with two force vectors generated mainly by the deltoid muscle in its anterior portion and the supraspinatus as a deltoid synergist. The deltoid's force vector of the deltoid will have the greatest magnitude and its direction will be towards cephalic, while the supraspinatus will generate a coaptation of the humeral head over the glenoid cavity, and in turn, given the fiber arrangement and the insertion, a



**Figure 1.** Different positioning angles. The centering of the dynamometer in projection of the glenoid cavity as center of rotation is noted.

Rotational moment and caudal glide of the glenohumeral joint. The vector resulting from the simultaneous activity of these two muscles will have a  $45^\circ$  direction towards cephalic, anterior and medial, whose center of instantaneous rotation will be located in the center of the joint, at the site of greatest compressive force of the humerus on the glenoid. Likewise, traction of the humerus will be performed on its anterior face by activation of the coracobrachial muscle and the biceps brachii in its short portion.

Given the disposition of the muscles, it is concluded that this movement is not performed in the pure sagittal plane but that it will lead to a movement with some abduction of the shoulder simultaneously with flexion<sup>5</sup>. Postural preparation prior to arm flexion responds to a vertical torque originated by the flexors<sup>3,5</sup>. The lever arm of the anterior deltoid during flexion is around 25-40 mm. The optimal length of the supraspinatus is 70 mm and the short head of the biceps brachii, 180 mm, which guarantees an active force throughout the trajectory, which must cover the full range of mobility. The deltoid acts in series with the anterior serratus,

who is the main antagonist, while the trapezius directs the clavicle and the scapula towards the plane of elevation; the rhomboids will keep the scapula stable against the thorax<sup>5</sup>, while the rotator cuff muscles are deep stabilizers of the shoulder joint. During flexion, the posterior muscles of the rotator cuff are more active than the anterior muscles<sup>3,5</sup>, providing dynamic stability and limiting the moments of translation. They even activate before the shoulder musculature, anticipating disturbances in the center of rotation and compressing the humeral head inside the glenoid cavity<sup>5</sup>.

This coactivation generates a significant flexor moment on the anterior aspect of the thorax, which will involve a displacement of the scapula anteriorly and with scapular rotation; for this, the scapular kinetics will involve a concentric activation of the serratus anterior muscle with anteriorization of the scapular vertex, concentric of the upper trapezius portion with medialization of the internal angle of the base of the scapula, eccentric activation of the subscapularis muscle as a fixator thereof to the thorax and eccentric activation of the rhomboid muscles as fixators of the entire

medial border of the scapula<sup>2,4</sup>. This kinetic is achieved in an ergonomic way and obtaining the maximum moments of stabilizing force if the movement is performed in the scapular plane, not during flexion in the sagittal plane. In addition, in this last movement the greater flexor moment will be performed by the coracobrachialis and biceps brachii muscles in the short portion; leaving in a second term the deltoid, whose cross-sectional area and force lever arm is greater<sup>2,4,5</sup>.

## CLINICAL IMPLICATIONS

Given these conditions of the biomechanics and kinetics of the joint complex of the shoulder, the positioning that we propose will integrate several aspects that should be considered:

1. A lower force moment on the anterior flexor muscles of the shoulder, allowing greater participation of the deltoid
2. An anatomical plane mechanics which will decrease the compressive moment in the subacromial space given the ergonomic kinematics of the joint
3. Further stabilization of the shoulder joint complex during activity
4. More symmetrical torques between the shoulder flexor and extensor musculature, with a more real behavior
5. A positioning with less complexity and more functional for the activities of daily life.

## PERSPECTIVES

This new position should be evaluated and reproduced to meet the following needs:

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This new position should be evaluated and reproduced to meet the following needs:

1. Establishment of normative values
2. Behavior of agonist and antagonist chains
3. Concentric and eccentric movements
4. Movements in classic and ballistic modalities available with Con - Trex<sup>®</sup>
5. Utility in different clinical situations such as tendinopathies, subacromial impingement or deltoid bursitis

The objective of this work (position design and biomechanical basis) has been completed, making it available to the scientific community as well as its employment and perspectives.

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## CONTRIBUTION

Pavel Loeza Magaña: Test design, initial writing of the article.

Ana Belén Aguilar Valencia: Execution of the test, review and expansion of the paper.

María Rosa Ramos Cuevas: Execution of the test, review and expansion of the paper.

## REFERENCES

1. Park SI, Choi YK, Lee JH, Kim YM. Effects of Shoulder Stabilization Exercise on Pain and Functional Recovery of Shoulder Impingement Syndrome Patients. *J. Phys. Ther. Sci.* 2013;25:1359-62
2. Shklar A, Dvir Z. Isokinetic strength relationships in shoulder muscles. *Clinical Biomechanics* 1995;10(7):369-73
3. Ellenbecker TS, Davies GJ. The Application of Isokinetics in Testing and Rehabilitation of the Shoulder Complex. *Journal of Athletic Training* 2000;35(3):338-50
4. Bélaïse C, Michaud B, Boucher M, Begon M. Do relevant shear forces appear in isokinetic shoulder testing to be implemented in biomechanical models? *Journal of Biomechanics* 2018;72:241-6
5. Veegera HEJ, Van der Helm FCT. Review: Shoulder function: The perfect compromise between mobility and stability. *Journal of Biomechanics* 2007;40:2119-29