CLOSED KINETIC CHAIN UPPER EXTREMITY STABILITY TEST (CKCUES TEST): BIOMECHANICAL ANALYSIS.

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SUMMARY

Functional tests are becoming an important clinical tool for providing objective data about a patient’s functional condition, and because they can be performed in clinics with low cost [1]. The CKCUES test is one test that could be considered as a clinical outcome measure for shoulder rehabilitation. However little is known about the effect this test might have on scapulohumeral kinematics. To date, there have been limited studies exploring the kinematics responses of the scapula during this dynamic stability test.

INTRODUCTION

The CKCUES Test is a functional upper extremity test performed in a push-up position that is being used as a complementary evaluation method during clinical rehabilitation in patients with shoulder impairments [1]. Previous research showed that the push-up exercise can decrease upward rotation and increase internal rotation, resulting in a glenohumeral joint position that may decrease the subacromial space [2]. Thus, the aim of this study was to describe shoulder scapular kinematics during the CKCUES Test to see if potentially deleterious scapular kinematic patterns are occurring.

METHODS

The study included 15 females, mean (SD) age of 23.8 years (2.91), height of 168cm (0.5), and weight of 60.66kg (8.26). Inclusion criteria included being female, right-hand dominant, sedentary, and healthy. The study was approved by the ethics committee of the Cuiabá Health and School Center of the Ribeirão Preto Medical School at the University of São Paulo.

Kinematic analyses of CKCUES Test were performed using electromagnetic tracking sensors (PolhemusTM) and an AMTI force plate. Sample rates were 120Hz and 240Hz, respectively. Data were sampled simultaneously using The Motion Monitor SoftwareTM (Innovative Sports Training, Inc., IL, USA). Sensors were positioned on scapula, humerus and thorax and anatomical landmarks were digitized according to International Society of Biomechanics (ISB) recommendations [3]. The center of humeral head was determined by the rotation method, rotating the arm passively to over 15 different positions [4].

RESULTS AND DISCUSSION

The CKCUES test is described as follows: the subject assumes a standard push-up position with hands at a measured distance apart, then during a 15 second timed sequence the patient leans over one hand and picks up the opposite hand reaches over to touch hands and then returns the hand to the starting position. This sequence is repeated with the opposite hand. The subject is scored on the number of complete hand-touch-hand placement sequences they can perform in 15 sec. Each volunteer performed three trials, with a 45 seconds rest between trials.

One hand of the subject was placed on a forceplate which was used as an event marker to determine the beginning and ending of each sequence (hand unloading >> hand loading sequence). The position of the scapula relative to the thorax was analyzed using the YX’Z” Cardan angle sequence (internal/external rotation, upward/downward rotation, anterior/posterior tilting) as defined by ISB recommendations [3]. The body weight-bearing on upper extremity was evaluated through vertical forceplate force normalized to body weight (FY/bw).

As each subject done a different number of touches during test perform, jus the three middle cycles were analyzed. The CKCUES Test analyzes were divided into load and swing phases and were done for dominant arm of volunteers. Load phase represents the movement performed since both extremities were in contact with floor, followed by the left hand movement towards right hand and ends with initial phase position. Swing phase represents the movement performed since both extremities were in contact with floor, followed by the right hand movement towards left hand and ends in the initial phase position. Phases were differentiated in The Motion Monitor software by defining events using the vertical ground reaction force. The three middle cycles during the 15 sec test of each volunteer were analyzed.

Descriptive statistics of scapular movements were done in each phase using peak and standard deviation values for scapular movements.

The load phase represented approximately 65% and swing phase 35% of the entire cycle (Figure 1). On stance phase,
scapular initial position was upward rotation (30.32), internal rotation (49.93) and anterior tilting (5.63), becoming more internally (64.1) and upwardly rotated (37.95) on the middle of load phase (right one-arm load), returning to a similar initial positioning at the completion of this phase. At the swing phase, internal rotation (60.35) and upward rotation (35.41) scapular movements values also increased with peak value obtained approximately on maximal right shoulder horizontal adduction, and at the end of this phase values returned to a similar initial position. Scapular tilting became more anterior at the end of load and beginning of swing phase (-4.2), going more posterior at middle of swing phase (-2.24), and at the end returning to a similar value of initial load phase (5.64) (Table 1). The FY/bw was 0.178, representing that approximately 17.8% of body weight was put in one arm during load phase.

This is the first study to assess explore the scapular kinematics during the performance of the CKCUES Test. This study demonstrated that approximately 17% of body weight loading occurred on one arm during load phase test, which was associated with an increased internal scapular rotation and a decreased upward scapular rotation. These findings are similar to previous studies evaluating weight-bearing during push up [4] and scapular kinematics [2] during a push-up exercise. The results of this study indicate that this test should be used with precaution as a clinical complementary evaluation in patients with shoulder impairments, mainly in patients with impingement syndrome.

CONCLUSIONS
The findings of this study of decreased upward rotation and increased internal rotation and of 17% of weight-bearing load on upper extremity during CKCUES Test performance indicate that clinicians should considered not using this test on initial phase of shoulder treatment as a complementary physical evaluation.

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REFERENCES

Table 1: Mean and Standard Deviation values of scapular kinematics during CKCUES Test cycle phases.

<table>
<thead>
<tr>
<th>Scapular movements (deg)</th>
<th>CKCUES Test Cycle Phases</th>
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<tbody>
<tr>
<td></td>
<td>Initial Load phase</td>
</tr>
<tr>
<td>Internal Rotation</td>
<td>49.93 ± 8.7</td>
</tr>
<tr>
<td>Upward Rotation*</td>
<td>30.32 ± 9.38</td>
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<tr>
<td>Anterior Tilting</td>
<td>5.63 ± 25.63</td>
</tr>
</tbody>
</table>

*Upward rotation was multiplied by (-1) for ease of interpretation.