PROPHYLACTIC EVALUATION OF SHOULDER PROPRIOCEPTION IN ELITE SWIMMERS

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It is suggested that poor shoulder proprioception contributes to shoulder pain in swimmers. However, there is a lack of studies describing the measurement method for shoulder proprioception. The purposes of this preliminary study was to investigate the scapular position depending on arm scaption as a first step in the development of a measurement method for three-dimensional shoulder proprioception. An asymptomatic young adults participated in this study. His scapular rotation were measured as a function of arm position during scaption in two consecutive days. The results showed that scapular rotations are not a reproducible function of humerus elevation. Those findings suggested that the assessement of shoulder proprioception should rely on the evaluation of both gleno-humeral and scapulo-thoracic joints to be valid.

KEY WORDS: shoulder pain, scapulo-thoracic joint, gleno-humeral joint.

INTRODUCTION: Swimming is an unusual sport in that it is performed in a fluid medium, which offers more resistance to movement than air, and in that the shoulders and upper extremities are used for locomotion, while at the same time requiring above average shoulder flexibility and range of motion for maximal efficiency (Ho & Laskovski, 2014). This combination of those unnatural demands can lead to a spectrum of overuse injuries seen in the swimmer's shoulder.

Overuse injuries of the shoulder causing pain are the most common cause of time lost to training in swimmers. This has led to numerous studies dealing with management of shoulder injuries in swimming over the past decades. The discussions regarding the function and examination of the shoulder and the models used to explain the incidence of shoulder pain in swimmers have historically been very mechanical in nature. It has lately been suggested that the origin of shoulder pain in swimming would lay in the complicated and poorly understood interaction between flexibility, strength, fatigue, muscle inhibition, muscle patterning and proprioception (Blanch, 2004), and that most swimmers would experience secondary (instability of the glenohumeral joint) rather than primary (decreased subacromial space) impingement (Belling et al., 2000). It is therefore there where the conservative management of swimmers with shoulder pain must have its effect.

It is suggested that shoulder proprioception contributes to shoulder stability and injury prevention. However, there is a lack of studies describing the measurement method for proprioception of the shoulder complex. The purpose of this preliminary study was to investigate the 3D scapular position as a result of humeral elevation in the scapular plan as a first step in the development of a reliable, valid, responsive and precise measurement method for three-dimensional shoulder proprioception, that would subsequently be used to study the effect of swimming practice on the shoulder proprioception in asymptomatic young adults. It is hypothesized that if the motion pattern of the scapula is a function of range of humeral elevation, then the study of humerus position/movement with respect to the thorax would be sufficient to estimated shoulder proprioception. Otherwise, evaluation of the proprioception of the shoulder complex would imply to evaluate the proprioceptive status of both the scapula-thoracic and gleno-humeral joints.

METHODS: A participant (age 21.0 years; height 168.0 cm; mass 69.0 kg) with no history of shoulder injury, surgery or medical problems volunteered for participation in this preliminary study which was approved by the local ethic committee.

Scapular and humeral kinematic data were collected at 100 Hz using an electromagnetic tracking device (Trackstar, Ascension Technology Corporation, Chicago, IL, USA), with three sensors located on incisura jugularis, on the flat portion of the acromion angle and at mid-height on the humerus. A fourth sensor was attached to a stylus used to digitalise bony landmarks (eighth thoracic vertebra, processus xiphoïdeus, seventh cervical vertebra, incisura jugularis, scapular angulus acromialis, trigonum scapulae, angulus inferior, humeral medial and lateral epicondyle) and allowed transformation of the sensor data from a global coordinate system to anatomically based local coordinate systems (Wu et al. 2005).

The participant, standing with hands on thighs and wearing sleeveless shirts, was asked to perform raised and lowered scaption (humeral elevation in the scapular plane, i.e. 30° anterior to the frontal plane of the trunk) twice with the thumb pointing up and a maximal range of motion. The same methodology was used again on the next day by the same experimenter to record the same movement so as to test for validity and reliability of this 3D marker based scapular motion analysis.

Raw kinematic data were filtered with a low-pass, fourth-order Butterworth filter with a cut-off frequency of 10 Hz. Euler angle decompositions were used to determine the scapular and humeral orientations with respect to the thorax using local coordinate systems defined in accordance with recommendations from the International Society of Biomechanics (Wu et al. 2005). Scapulothoracic rotations were defined as internal/external rotation, medial/lateral rotation and anterior/posterior tilt.

The orientation of the scapula was analyzed during raised and lowered scaption at 30°, 60° and 90° of humeral elevation (Lempereur et al., 2014) for both days.

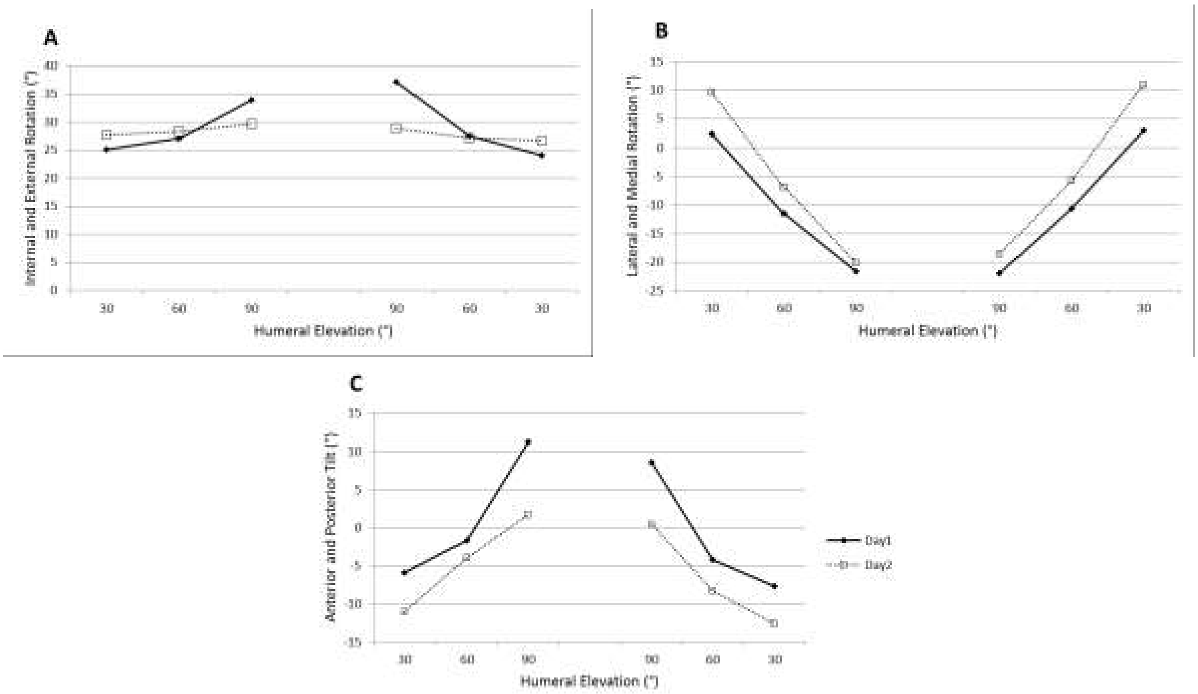

Figure 1: Internal/external rotation (A), lateral/medial rotation (B) and anterior/posterior tilt (C) for raised (first 3 points) and lowered (last 3 points) scaption at 30°, 60° and 90° of humeral elevation for both days.

RESULTS: For the three humeral elevation of both raising and lowering scaption, the scapular angles were not reproducible from one day to the next as illustrated in Figure 1. Similarly, the motion pattern of the scapula did not appeared to be a function of range of humeral elevation either for raising or lowering scaption.

DISCUSSION: For the past two decades there has been an increase in the appreciation of the contribution of the neurophysiological feedback mechanisms involved in the control of movement of the shoulder (Myers & Lephart, 2002; Safran, Borsa, Lephart, Fu & Warner, 2001). It is now established that the stability of the scapula relies not only on a balanced functioning of the scapular muscles, but also on the fine self-adjustment of the sensorimotor system including various components of proprioception such as the joint position sense, kinesthesia, and the sensation of force (Myers et al., 2006). In spite of the importance of the position and stability of the scapula and shoulder girdle to provide a stable platform from which to work for the shoulder and arm to function efficiently during the swimming stroke (Ho & Laskovski, 2014) there has been no research to date that specifically addressed the necessity to evaluate separately the proprioceptive status of each of the joint constituting the shoulder complex.
The present study revealed that the scapular rotations are not a reproducible function of humerus elevation angle. In addition, the motion pattern of the scapula varied for a given range of humeral elevation. Shoulder joint proprioception can thus not be evaluated based solely on the proprioception of the humerus relative to the thorax but should rely on the evaluation of both scapulo-thoracic and gleno-humeral joints.
Joint proprioception is usually evaluated using a quantification of either Joint Position Sense, measured by the difference between an assigned joint position and its repositioning or kinesthesia, measured by detecting the onset of motion. Test validity and intra-rater reliability in the measurement of scapular position sense as already been demonstrated in asymptomatic young adults (Deng & Shih, 2015). The generalizability of the use of such a test for symptomatic and/or elite population remains to be demonstrated. In addition, the interest of other proprioceptive tests for this or the gleno-humeral joint remains to be investigated.

CONCLUSION: Internal/external rotation, medial/lateral rotation and anterior/posterior tilt of the scapula are not function of humero-thoracic movements. A reliable, valid, responsive and precise measurement method for three-dimensional measurement of the position/movement of the humerus relative to the thorax would thus not be sufficient to characterise shoulder proprioception. The concurrent evaluation of the proprioceptive status of the scapulo-thoracic and gleno-humeral joints is thus necessary to study the effect of swimming practice on the shoulder proprioception, a prerequisite to prevent shoulder syndrome.

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Funding

This research was supported by « Ministère des Sports, de la Jeunesse, de l'Education Populaire et de la Vie Associative » and « Institut National du Sport, de l'Expertise et de la Performance » [n°14r24].