

MEASURING GLENOHUMERAL JOINT TRANSLATIONS USING MOTION ANALYSIS TECHNIQUES

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INTRODUCTION

The shoulder is the joint complex with the greatest range of movement in the human body. It is made up of four articulations: the sternoclavicular (ST) joint, the acromioclavicular (AC) joint, the glenohumeral (GH) joint and the scapulothoracic (ST) articulation. The large movements that arise from the GH joint are due to the lack of bony stability offered by the shallow glenoid cavity. Therefore the joint relies on a complex of ligaments and muscles to maintain stability within the joint. Once these stabilizers have been compromised, the joint may become permanently unstable and translation of the humeral head in the glenoid cavity would be observed.

Motion analysis techniques have been developed over the past years to measure the kinematics of the shoulder complex. The GH centre of rotation must be estimated in order to create the humerus coordinate system and thus perform the kinematics analysis. This “virtual” landmark can be estimated through a number of different techniques, including regression equations [1], SCoRE method [2] and the helical axis (HA) method [3], some approaches are more suitable than others. Translations in the GH joint are commonly measured using the HA method.

Cardiff University has been approached by an Orthopaedic surgeon keen on measuring GH translations in first time dislocators. His main interest is to determine whether there is a correlation between measured GH translation and dislocation recurrence, with the aim of predicting which first time dislocators will go to develop instability. The aim of this study is to explore the feasibility of measuring translations of the GH centre of rotation, using matrix decomposition, during arm elevation.

METHODS

An 8 camera Qualisys ProReflex MCU array (Qualisys Sweden) with a sampling frequency of 60 Hz was used to collect 3-dimensional in vivo kinematic data of the whole shoulder complex.

Five healthy male subjects (mean age 22.8 ± 2.2 years, height 1.80 ± 0.7 m and weight 76.2 ± 13.3 Kg), with no previous history of shoulder pathology or instability were assessed. Retro reflective markers were attached to the bony landmarks of the arm and torso according to International Society of Biomechanics (ISB) recommendations for the upper extremity [4]. The GH centre of rotation was estimated through regression equations [1].

The subjects were instructed to perform bilateral arm elevation range of motion (ROM) in flexion and abduction in a seated, upright position, were only the right arm was evaluated. A frame was used to standardise arm elevations at 20° intervals up to 180° . Static measurements were recorded

using the Newcastle Scapula Locator (NSL – a three pointed palpator with retro-reflective markers used to measure more accurately the kinematics of the scapula) [5].

RESULTS AND DISCUSSION

Translations in the GH joint were calculated through matrix decomposition. GH anterior- posterior translations and inferior- superior translations are shown in Figures 1 and 2 respectively during abduction.

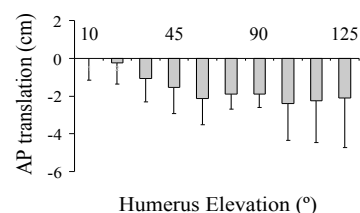


Figure 1: Anterior – Posterior GH translations. Negative values indicate posterior movement of the humeral head

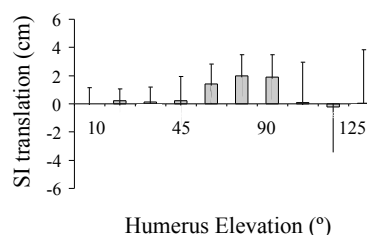


Figure 2: Superior – Inferior GH translations. Positive values indicate superior movement and negative values indicate inferior movement of the humeral head.

The GH centre of rotation was found to displace posteriorly by $2.41\text{cm} \pm 1.27\text{cm}$ and superiorly $2.23\text{cm} \pm 2.20\text{cm}$ up to 90° of humerus abduction. Above 90° , the GH displaced inferiorly. The patterns of motion are in accordance to what is published in the literature [6] although the ROMs are greater by an order of magnitude.

CONCLUSIONS

Translations in the GH joint were greatly overestimated when performing matrix decomposition, which was expected from the skin fixed marker system. If the errors introduced with the skin fixed marker system can be calibrated against a more sophisticated method, it could be a powerful tool to measure GH translations.

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