A STANDARDISED PROTOCOL ASSESSING ACTIVE AND PASSIVE GLENOHUMERAL RANGE OF MOTION
Alexander Humphries1, Srdjan Cirovic1, Anthony M.J. Bull2, Aliah F. Shaheen1
1 Centre for Biomedical engineering, Department of Mechanical Engineering, University of Surrey, UK; 2 Department of Bioengineering, Imperial College London, UK

Introduction
The extremes of motion of the glenohumeral joint provides an indication shoulder function in loaded activities such as sports, and are used diagnostically for pathologies. Establishing the passive and active range of humeral internal-external rotation for a variety of elevation planes and angles enables shoulder function and stability to be assessed (Novotny, 2000). There is limited consensus for the optimal approach to define the glenohumeral joint’s range, leading to numerous methods of evaluation. Clinically, the range of motion is frequently assessed by eye, applying torques manually. This has limited reliability since the humeral elevation angle and plane are not maintained and the motion of the scapula is not isolated. Therefore there is a need to develop a clinically-applicable protocol to improve the reliability of the resulting range of motion. Previous studies investigating the kinematics of the shoulder conclude that isolation of the glenohumeral joint is required (McCully, 2005). However, there is no standardised protocol to evaluate the range of motion across a range of elevation angles and planes. This study aims to develop a protocol for assessing passive and active range of motion in order to quantify and compare between various subject groups, angles and planes to improve reliability of the resulting glenohumeral range.

Methods
A restraint chair was developed and tested using an optical motion system, where coordinate frames and Euler rotations followed ISB standards in joint angle calculations. A torque application device was developed to control passive motion and maintain humeral elevation plane and angle. Preliminary data was collected using the protocol to optimise system setup with the acromion marker cluster positioned optimally (Shaheen, 2011). The reliability of the measured range of motion and elevation angle were used to evaluate the protocol’s effectiveness compared to existing protocols.

Results
The device, shown in Figure 1 restricts the elevation plane and angle during internal-external rotation. The lateral supports were shown to reduce thorax lateral motion, while the harness reduced thorax axial rotation and flexion in order to isolate glenohumeral motion. The tripod was used to control the humeral elevation angle within each elevation plane assessed. Measurement of the elevation angle in real-time improved reliability, compared to using a goniometer.

Discussion
The applied torque and the angle of the forearm relative to the global coordinate system were measured in real time. This allowed the torque applied about the glenohumeral joint to be calculated by considering the influence of the weight of the forearm during rotation. Although the restraint device allowed the elevation plane and angle to be controlled whilst restraining the thorax, the internal rotation was limited at lower elevation angles due to obstruction by the thorax.

References