GLENOHUMERAL TRANSLATION DURING DYNAMIC TASKS IN HEALTHY PARTICIPANTS

Benjamin Michaud[1,3], Fabien Dal Maso[1,3], Arne Lundberg[2,3], Toni Arndt[2,3], Paul Allard[1,3], Mickaël Begon[1,3]

[1]Université de Montréal, Canada; [2]Karolinska Institutet, Sweden;- [3]Scapulo-Humeral Investigation Team

Introduction

In human movement, models consider the glenohumeral (GH) joint as a perfect ball-and-socket joint. However, during static contractions, motion of the center of rotation (CoR) of the humeral head relatively to the glenoid (GH translation) has been observed by Chan [1996]. These translations of a few millimetres are responsible for joint instability [Chan, 1996]. For clinical purposes, it is of interest to evaluate three dimensional GH translations during dynamic contractions. Imaging techniques currently used to quantify GH translation have too low frequency sampling rates to record movements while surface markers have limited accuracy because of skin motion artifacts [Karduna, 2001]. Hence, a technique that consists in recording kinematics of intracortical pins can more accurately assess GH translations [Ludewig, 2009]. The objective was to describe for the first time GH translation for a large selection of dynamic movements in healthy individuals.

Methods

Four asymptomatic participants took part in the study. Clusters of 4 to 5 markers were secured on intracortical pins surgically inserted in the scapula and humerus. Markers trajectory was collected using an 18-camera motion analysis system (Vicon, UK, 300 Hz). The functional method SCoRE [Ehrig, 2006] was used to compute the CoR. Participants performed relaxed position trial [Jackson, 2012] and then performed standardized movements (flexions, abductions, downward and abducted external rotations), daily living tasks (eating, combing hair and reaching back, pocket and opposite axilla) and sportive activity movements (tennis forehand, ball throwing, punching and hockey shooting). Kinematics were reconstructed using local optimisation with 6-DoF for both segments. GH translations were defined as the difference between the CoR at time *t* and that obtained in the relaxed CoR, both represented in the scapula local system of coordinates.

Results

Figure 1 shows the results obtained during reaching opposite axilla. Maximum translations to values (4 mm) were at -90°, 30° and -40° in the plane of elevation, elevation and axial rotation respectively. Translations were close to zero in the anatomical position.

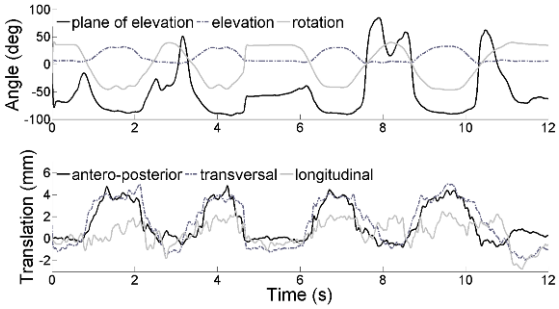

Fig. 1: Humerus angular position (upper graph) and GH translation (lower graph) of a representative participant during reaching opposite axilla.

Discussion

Translations during dynamic contractions are similar to those found during static contractions [Graichen, 2005]. Since Massimini [2012] reported that translation increases the tension in the ligaments, large motion amplitudes could be discourage for individual with shoulder disorders. Moreover, since muscular activation of the shoulder alters GH translation [Graichen, 2005], it could be of interest to determine which movements induce smaller translations.

References

Chan, *et al*, Clin Orthop Relat Res, 323:106-12, 1996.
Ehrig *et al*, J Biomech, 39:2798-809, 2006.
Jackson *et al*, J Biomech, 45:2180-3, 2012.
Graichen *et al*, J Biomech, 38:755-60, 2005.
Karduna *et al*, J Biomech, 123:184-90, 2001.
Ludewig *et al*, J Bone Joint Surg Am, 91:378-89, 2009.
Massimini *et al*, J Orthop Surg Res, 28:7-29, 2012.