Estimating Upper Extremity Joint Contributions in Functional Motions to Create a Metric for Injury Prevention using OpenSim

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Functional movements have the potential to predict risk of injury based on the frequency of these movements on a daily basis. In order for a metric to be established, a variety of healthy subjects must be recorded performing these motions. It was predicted that motions covering a large three-dimensional workspace will require greater contributions from the shoulder joint, while motions with more of a planar workspace will require greater contributions from the elbow joint. Ten subjects, five male and five female, performed two different functional tasks involving the upper extremity. Pointing and drinking tasks were selected based on the frequency that these tasks are performed on a daily basis. Each subject was affixed with passive reflective markers according to a previously developed OpenSim upper extremity model. The subject performed each task eight times while being recording with a Vicon camera system. The five trials with the least amount of marker exclusion were chosen for analysis. The inverse kinematics and dynamics for each trial were determined using OpenSim and then filtered through a low pass filter. The resulting ranges of motion for shoulder elevation and elbow flexion for both the drinking and pointing tasks were as expected. For the drinking task, the majority of subjects flexed their elbow 60° and their shoulder elevation fluctuated between 30-50°. For the pointing task, the majority of the subjects elbow flexion varied no more than 10°, and their shoulder elevation fluctuated between 70-95°. Figure 1 shows the results of one of the subjects. From this preliminary study, it is observed that most of the subjects use similar kinematics to accomplish each task; however, several of the subjects displayed irregular kinematics during some of their trials. Overall, these results are consistent with previous studies [1]. This preliminary study provides a foundation for future studies focusing on injury prevention and performance enhancement for athletes. A range of functional movements will be recorded and analyzed to develop quantitative metrics that will serve as indicators for potential injuries and will also be used to inform training protocols aimed at reducing the overall risk of injuries for athletes.