ANALYSIS OF MUSCLE ACTIVATION IN THE SHOULDER MECHANISM DURING MANUAL WHEELCHAIR PROPULSION

Hassanain Ali Lafta¹, Robert Guppy¹, Paul Biggs¹, Gemma Whatling¹, Cathy Holt¹

¹ Institute of Medical Engineering and Medical Physics, School of Engineering, Cardiff University, UK

Introduction

Manual wheelchair propulsion is a daily life repetitive task which is primarily controlled by the upper limb and leads to biomechanical alterations that play a key role in triggering muscle imbalance and pain. It has been widely shown that manual wheelchair users have a high prevalence of upper limb injuries. Researchers have underlined that muscles involved during propulsion are one of the major causes of injuries, [1]. The purpose of this study is to analyse the electromyographic (EMG) activity of shoulder stabilising muscles during manual wheelchair propulsion.

Method

Five healthy male individuals (4 right-hand dominant and one left-hand dominant, mean age 20.4 ± 0.8 years, height 1.84 ± 0.058 m, and weight 78.4 ± 13.9 kg) with no previous experience with manual wheelchair propulsion and no history of shoulder pain or pathology, were participated in the study after giving their written informed consents.

Surface electromyography (sEMG) signals were recorded on seven shoulder muscles, of each subject's dominant arm. DELSYS Trigno wireless EMG system was used to measure the EMG signals of these muscles, which were recruited for their well-known contribution to wheelchair propulsion, while propelling a manual self-propelled wheelchair along 10 meters linear path in the Motion Analysis Lab in Cardiff University at self-selected pace, Figure (1).

Prior to propulsion, a set of four tests were performed for inducing a maximum voluntary contraction (MVC) in each muscle. These standard tests were identified in terms of normalising the EMG activity of the shoulder muscles reliably, [2]. These four tests involve: empty can, internal rotation 90°, flexion 125° and palm press.

Each raw EMG data was exported to MATLAB software for signal analysis and post acquisition processing. Raw EMG signals from the propulsion trials and MVC tasks were pre-amplified, high-pass filtered by a Butterworth fourth order filter at (20 Hz), full wave rectified, and low pass filtered with a fourth order Butterworth filter at (6 Hz). Muscle activation was described as the linear envelope of the signal so as to eliminate ambient noise through the high-pass filter, and smoothen the curve through full-wave rectification and the low pass filter.

It was shown that two muscle synergies have been identified during wheelchair propulsion, namely push phase synergy and recovery phase synergy. The push phase synergy is dominated by the anterior deltoid, pectoralis major, and biceps brachii, whereas upper trapazius and posterior deltoid have their primary activity during the recovery phase, [3]. In the propulsion phase, the participants are required to follow the push rim path, whereas in the recovery phase they can choose among many paths to return the arms and hands to the initial push position, Figure (2).

Results and Conclusion

EMG signals were recorded at a sampling frequency of (1080 Hz) by testing a developed protocol.

References