UPPER EXTREMITY 3D KINEMATICS AND MUSCULOSKELETAL EFFORT IN LAPAROSCOPY

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Introduction
In order to foster safer workplaces and to cope with Work Related Musculoskeletal Disorders, an ergonomic intervention is required for managing the biomechanical risk factors that appear during laparoscopic surgery tasks. However, to the best of the authors' knowledge, there is a lack of information concerning the measurement of the posture adopted by surgeons in terms of clinically interpreted position and orientation of body segments. Therefore, the aim of the study was the measurement of the three dimensional upper extremities kinematics during laparoscopic activities in operation conditions in order to determine the influence of the surgeons’ adopted postures on the appearance of localized muscle fatigue.

Methods
The measurement chain consisted of a video-based optoelectronic system (Kinescan/IBV) that allows the reconstruction of the 3D coordinates of the body landmarks, and an EMG system with surface electrodes to register the intervention of the left and right side of the middle deltoid and upper trapezius muscles. 3D kinematics analysis has been used to define by means of Cardan/Euler angles the rotation of the upper arm with respect to the trunk [Wu, 2005; Anglin, 2000]. The EMG signal was detected by an 8ch unit, using an analog differential amplifier (gain up to 2000 V/V, CMMR 90 dB, input impedance > 100 MΩ) and band-pass filtered (10-1000 Hz) prior to digitalization. The analog signal was sampled via a 12-bit data acquisition card (DATAQ, DI-200 PGH) at 1200 Hz and stored in ASCII file. Localized muscle fatigue was assessed by measuring the shift over time of the median frequency of the EMG power spectrum [Chaffin, 1973].

Results
3D kinematics defined by means of Cardan/Euler angles the rotation of the upper arm (azimuth angle-elevation angle) with respect to the trunk (Figure 1). The spectral analysis of the EMG signal revealed that 92% of the subjects suffered from localized muscle fatigue (Figure 2).

Discussion
The pair movement of the surgeons’ upper arm with respect to the trunk during the laparoscopic operation was analysed, allowing the measurement of the posture adopted by surgeons in terms of clinically interpreted position and orientation of body segments (Figure 2). It was confirmed the hypothesis that surgeons suffer of localized muscle fatigue due to prolonged static contractions.

References