

ELECTROMYOGRAPHIC ANALYSIS OF THE DOMINANT UPPER LIMB DURING THE GOLF SWING

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Abstract

Purpose: The identification of neuromuscular patterns is an important cue for the management of muscular development, skill improvement and injury prevention. The main purpose of the present study was to characterize muscular coordination patterns in the dominant upper limb in the different phases of golf swing in experienced golfers.

Methods: Three low-handicap golfers (handicap lower than five) performed six full swing movements with a pitch iron. Surface electromyography (EMG) was recorded from 12 muscles: anterior (AD), middle (MD) and posterior (PD) deltoids, pectoralis major (PM), latissimus dorsi (LD), infraspinatus (IS), vastus lateralis (VL) and long portion (LP) of triceps brachii, biceps brachii (BB), brachioradialis (BR), wrist flexors (WF), and wrist extensors (WE). The EMG signals were sampled at 1000 Hz, full wave rectified, low pass filtered (second order Butterworth filter at 12 Hz) and normalized using the EMG of the maximal voluntary contraction (MVC) as a reference. In synchrony with the EMG signals, a three axis accelerometer fixed at the back of the golf club head informed about ball contact time (BC). Mean EMG value was calculated separately during each phase: backswing (BS), downswing (DS) and the first 500 ms of the follow-through (FT). For the movement analysis and phase delimitation the swing was filmed with four high speed video cameras (300 Hz). The recording of EMG and cinematic data was performed with a SIMI system (SIMI Motion, Munich, Germany).

Results: The average of normalized values of all muscles of the dominant arm in the three subjects, showed that the DS exhibited the highest muscular activity (28,8% of the EMG of the MVC) compared with the FT (19,9%) and the BS (15,7%). The elbow flexors (BB 26%, BR 45%) and the wrist extensors (WE 26%) presented the strongest activation during the BS to promote elbow flexion and hand extension, and silenced before the DS initiation. During the DS the shoulder adductors (LD 53%, PM 38%) and the elbow extensors (LP 50%, VL 47%) presented the highest EMG activation. These muscles were activated at the beginning of the DS but the shoulder adductors peaked earlier. The AD peaked 70 ms before the BC and its activation may contribute to the arm internal rotation during the acceleration phase. The WF peaked during or just after the BC to accelerate hand flexion. The shoulder abductors (AD 34%, MD 14%) and the wrist flexors (36%) showed the highest activity during the FT. The posterior and middle deltoids showed low activity in all the phases (less than 20%).

Conclusions: The results demonstrated that the most active muscles during the golf swing were the shoulder adductors and the elbow extensors, and that the downswing was the phase where muscles from the dominant upper limb presented stronger activation. The EMG patterns we found can help to design training programs to improve strength and flexibility and to reduce injury risk in the golfers upper limb.