

EMG OF ELBOW FLEXOR-EXTENSOR MUSCLES AS A FUNCTION OF JOINT ANGLE IN YOUNG OVERHEAD ATHLETES

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INTRODUCTION

Recent studies report that the electromyographic (EMG) activity of the elbow flexors and extensors is not affected by altering the joint angle [1], whereas an increase in the EMG amplitude normalized with respect to maximum force of the biceps brachii and brachioradialis muscles was shown at short muscle length [3]. The purpose of this study was to examine the EMG activity of the elbow flexor and extensor muscles as a function of joint angle in athletes specializing in striking and throwing actions.

METHODS

The sample consisted of elite young volleyball (VB, $n=10$), handball (HB, $n=11$) and water-polo (WP, $n=10$) athletes. Subjects' characteristics (mean \pm SD) were for VB: 17.2 \pm 1.0 yr, 80.0 \pm 8.0 kg, 185.7 \pm 5.1 cm, HB: 15.5 \pm 0.9 yr, 77.1 \pm 6.5 kg, 179.6 \pm 7.3 cm and WP: 15.2 \pm 0.9 yr, 76.1 \pm 15.0 kg, 174.8 \pm 8.0 cm, respectively. Subjects executed 3-s maximum voluntary elbow flexion–extension contractions (MVC) on a Cybex II+ dynamometer at angles of 45-60-75-90-105-120° of joint flexion (0°=full extension) in a random order, while being in a supine position with the shoulder joint at 45° of horizontal abduction and the forearm in neutral position. The maximal isometric flexor–extensor moment of force (M) was calculated. Surface EMG was recorded from the biceps (BB, caput longum and caput breve) and triceps brachii (TB, caput longus) muscle (MP100A, Biopac Systems). Electrodes were located according to SENIAM [2] recommended locations for each muscle with a fixed inter-electrode distance of 2 cm. EMG signals were amplified and sampled at 1000 Hz synchronized with force signals (Biopac Systems; AcqKnowledge software). The root mean square (RMS) value of the MVC EMG data was calculated. To determine the amount of EMG needed per unit of moment of force produced by BB and TB muscles, RMS of each muscle was divided by M in elbow flexion and extension (RMS_BB/M, RMS_TB/M). A repeated-measures anova (Joint angle (6) x Group (3)) was applied to assess possible differences among elbow joint angles and groups on RMS_BB/M and RMS_TB/M (SPSS, v.13). Statistical significance was set at $P<0.05$.

RESULTS AND DISCUSSION

Results are presented as the mean over the three sport groups (Figure 1), because no main effect was found for the factor group and no interaction effect was found among joint angle and group. Elbow joint angle had a significant ($P<0.001$) main effect on the normalized EMG activity; pairwise comparisons revealed significant differences among the six joint angle positions (Table 1), showing that the RMS_BB/M increased at joint angles of greater flexion (or shorter muscle length) and that the RMS_TB/M also increased at joint angles of greater flexion (or longer muscle length) (Figure 1).

Table 1: Significance of pairwise comparisons for RMS_BB/M and RMS_TB/M (in italics) among the six elbow joint angles, independent of the three sport groups.

RMS_BB/M and RMS_TB/M						
	45°	60°	75°	90°	105°	120°
45°	-/-	**/ns	***/*ns	**/*ns	ns/*	*/**
60°	-/-	-/-	**/*ns	ns/*	ns/***	**/***
75°	-/-	-/-	-/-	*/ns	**/***	**/***
90°	-/-	-/-	-/-	-/-	*/**	**/***
105°	-/-	-/-	-/-	-/-	-/-	**/*ns

* $P<0.05$, ** $P<0.01$, *** $P<0.001$.

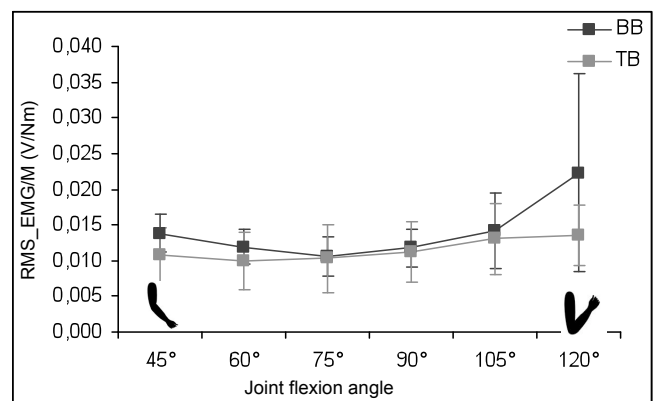


Figure 1: RMS_BB/M and RMS_TB/M values as a function of elbow joint angle. Data (mean \pm SD) are averaged values over the three groups.

The finding that the EMG activity of both BB and TB was increasing as the joint was more flexed probably suggests an adjustment in neural activation of the muscles as compensation to the mechanical disadvantage of the shortened (for BB) or lengthened length (for TB). Similar results have been reported for BB [3] and were related to the muscle's broad operating range on the isometric F-L curve [4]. The relationship between EMG activity and joint angle appeared different between BB and TB and could be related to the relatively small length and force changes across the range of elbow joint angle for TB [4]. The similar changes in EMG activity of elbow muscles as a function of joint angle observed in these young overhead athletes may be associated with adaptations of muscle function to similar functional requirements during striking and throwing actions.

REFERENCES

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