

MUSCLE LENGTH AND ITS MOMENT ARM OF ELBOW MUSCLES DURING ELBOW FLEXION AND EXTENSION

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INTRODUCTION: The exterior movement, the form of muscle movement and the coordination of muscle movement have been studied. However, quantitative analysis of mechanical character of muscular movement would be important. The purpose of this study was to qualitatively examine the length and moment arms of elbow muscles during elbow flexion and extension.

METHODS: Ten males (23.4 ± 1.3 years, 1.74 ± 0.35 m) and ten females (24.0 ± 1.1 years and 1.66 ± 0.41 m) major in physical education were randomly selected from university. The X-ray photo of front and side of upper limbs were taken. On the radiography films, elbow joint centre origin point and insertion point of muscles was marked. Maximum range of motion of elbow joint was measured by fixed-point and fixed-focus photograph measurement and STK video analysing system. Subsequently, the program was written and motion of elbow joint was simulated in the computer.

RESULTS: In the process of inflexion of elbow joint, sequence of absolute length changes was as follows: biceps (7.69 ± 1.19 cm), brachialis (6.23 ± 1.05 cm) and brachioradialis (3.67 ± 0.89 cm). The relative length changes were $47.19 \pm 6.88\%$ in brachialis, $20.49 \pm 3.21\%$ in biceps. and $13.21 \pm 3.57\%$ in brachioradialis. The maximum moment arm of muscle action in the elbow joint were 4.17 ± 0.54 cm in biceps, 3.67 ± 0.57 cm in brachialis, and 2.83 ± 0.42 cm in brachioradialis. When the moment arm of a muscle line of action about the elbow joint of biceps, brachialis and brachioradialis were at maximum, angles of elbow joint were $90.13^\circ \pm 8.47^\circ$, $61.63^\circ \pm 4.60^\circ$ and $146.4^\circ \pm 17.73^\circ$ respectively. When total of the moment arm of muscle action in biceps, brachialis and brachioradialis were maximum (14.06 ± 1.88 cm), angles of elbow joint were $75.3^\circ \pm 8.45^\circ$. (at the start-position of inflexion, the elbow joint extends completely). When elbow joint was extended, absolute length and relative length of triceps and anconeus were changed a little, which was the principal function. Also, the maximum moment arm of muscle action in the elbow joint was less.

CONCLUSION: This study showed that the absolute length change and maximum moment arm of muscle action of biceps were greatest and relative length change of brachialis were greatest in the process of inflexion of elbow joint. It was a specific sequence causing muscles to reach maximum moment arm of muscle action in the elbow joint respectively. In the process of extension, length change and moment arm of a muscle action of triceps and anconeus were less. These results support the hypothesis that the force of extension would be less than inflexion.

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