RIB CAGE MOTION PATTERNS IN SWIMMERS DURING RESPIRATORY MANEUVERS

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INTRODUCTION

Breathing is a dynamic act in which the coordinate motion of the rib cage increases and decreases its volume. Studies show that lung volumes [1] and respiratory motion patterns [2] can be changed by the practice of exercises and respiratory techniques. This work aims to verify if the rib cage motion patterns are altered in swimmers during respiratory maneuvers.

METHODS

The methodology is based on the kinematical analyses of 38 markers attached to the volunteer's trunk representing the rib cage (figure 1) using the DVideo system [3]. A group of 11 male swimmers (SG) was compared to a control group (CG) of 9 non-athletes volunteers during tidal volume (TV) and vital capacity (VC) maneuvers in sitting position. The rotation angles among the coordinate system associated to each pair of ribs and the coordinate system associated to the trunk were calculated in function of time (figure 2). The curves of rotation angle around the quasi-transverse axis were correlated. All combinations of two curves from the 2nd to the 10th ribs were tested. Considering that the correlation coefficient did not present a normal distribution, a transformation was applied according to Fisher (z-transformed correlation coefficient). In order to verify the statistical difference between groups t-tests ($p<0.05$) were performed.

RESULTS AND DISCUSSION

No significant differences were found between the two experimental groups during TV breathings. The figure 3 shows the distribution of the transformed correlation during VC maneuvers using a Box-plot representation. Significant higher values were found in the SG correlating the ribs (2,3,4,6,7,8,9) to the 10th and correlating the 2nd with the 9th rib. It can be seen that the distribution of z-correlation coefficient of the 2nd with the 10th ribs presents significantly higher median values and reduced dispersion in SG. It is also remarkable that the median values of the z-correlation decrease with the increment of the distance between the two ribs considered. The 9th and 10th ribs are important as region of apposition between diaphragm and rib cage. The higher correlation values in SG suggest an optimized pattern and reinforce the idea that practicing swimming can promote positive changes in the respiratory pattern.

CONCLUSIONS

The results obtained suggest that swimming practice lead to the formation of optimized breathing pattern when larger efforts are required from the respiratory system. This study also showed the viability of using the 3-D kinematical analysis to evaluate respiratory motion patterns.

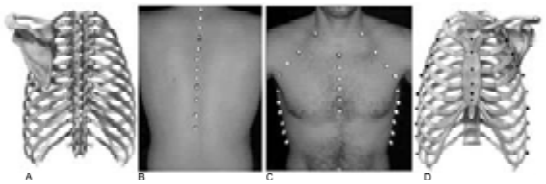

Figure 1: Representation of the rib cage using external markers

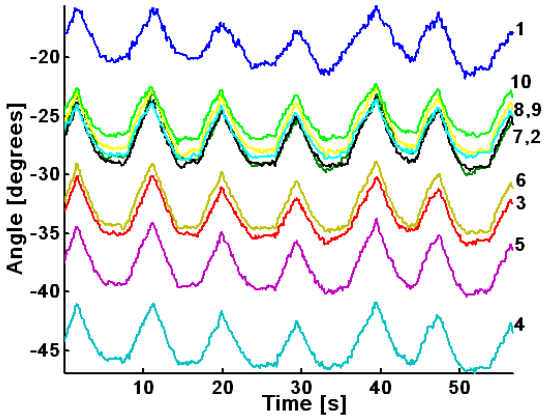

Figure 2: Example of ribs rotation angles around the quasi-transverse axis for one volunteer in VC.

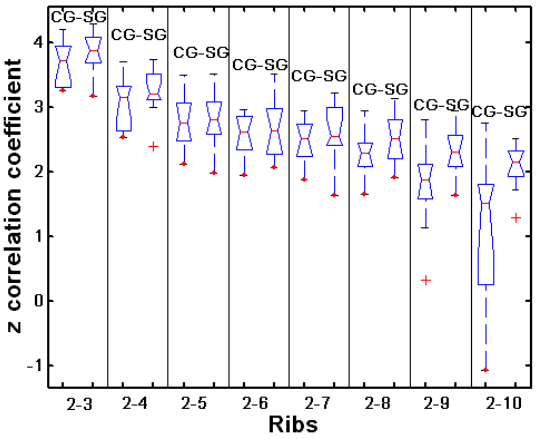

Figure 3: Distribution of the z-transformed correlation coefficient values of the 2nd rib with the other ribs during VC

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