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WHEELCHAIR RUGBY IMPROVES THORACOABDOMINAL MOBILITY IN PEOPLE WITH TETRAPLEGIA AFTER ONE YEAR OF TRAINING

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SUMMARY

This study investigated the effects of one year of regular wheelchair rugby training on thoracoabdominal mobility of subjects with tetraplegia. Seven male subjects, tetraplegic level C5-C7 were analyzed before and after a year of training in wheelchair rugby the three-dimensional kinematic analysis of thoracoabdominal mobility of four regions: superior thorax (ST), inferior thorax (IT), superior abdomen (SA) and inferior abdomen (IA). Kinematic analysis showed a significant increase of 31.4% ($p = 0.004$) in the thoracoabdominal mobility of the superior thorax, after the training period, and there were no significant differences in other compartments analyzed. Therefore, the one year training of wheelchair rugby had a positive impact on mobility of the superior thorax in individuals with tetraplegia, and allows the identification of ST as thoracoabdominal region that contributed most to the increase in lung volume in population.

INTRODUCTION

Respiratory dysfunction is a common complication for people with high spinal cord injuries and there are many consequences resulting from the changes in respiratory function of these individuals². Changes to breathing mechanisms may lead to changes in the configuration and components thoracoabdominal breathing pattern^{7,10}. The regular practice of sports can be used to assist the improvement of the respiratory system in quadriplegics². Thus, the participation of tetraplegic individuals in this sport can foster beneficial organic adaptations, and help to ensure that they reach the levels recommended for the prevention and control of diseases. The wheelchair rugby is a sport designed for individuals with disabilities in at least three members. It requires aerobic and anaerobic capacities in the same game. The kinematical analysis of chest wall movements during breathing can provide relevant information about respiratory mechanics as well as to quantify the total air volume changed in time, to measure the contribution of different regions of the trunk during breathing and to analyze the relationship of these variables with the muscular action^{1,6,9}. So, the present study aimed to evaluate the effects of a year of training in wheelchair rugby thoracoabdominal mobility of individuals with tetraplegia using the kinematical analysis of chest wall during breathing.

METHODS

Seven male subjects with tetraplegia participated in this study, under the following inclusion criteria: level of injury between C4 and C8, time of injury over 12 months, stable clinical condition, practice in wheelchair rugby at least twice a week and/or four hours a week, with training time exceeding six months, nonsmokers, without acute respiratory complications or history of cardiopulmonary diseases. Exclusion criteria were: development of respiratory diseases or interruption of training. The volunteers were evaluated in two periods: the first evaluation was performed after the II Wheelchair Rugby National Championship, in June 2009, and the second evaluation after one year, after the III Wheelchair rugby National Championship, in June 2010. The project was approved by the ethics committee of the institution under protocol and all volunteers signed an informed consent form.

To data collection, the volunteers remained sat on an adapted chair with shoulders abduction of 70°, forearms supported, 90° of knee and hip flexion and feet on the ground. Thirty spherical retroreflective markers ($\varnothing=5\text{mm}$) were fixed to the trunk according to a model presented by Sarro et al (2009). The three-dimensional coordinates of the markers were obtained with kinematical analysis system DVideo, with 6 digital genlocked Basler cameras arranged around the subjects. They performed five breathing with maximum inspiration and expiration. According to the previous model, the trunk was split in four compartments: superior thorax (ST), inferior thorax (IT), superior abdomen (SA), and inferior abdomen (IA). Each compartment was geometrically defined as the sum of two irregular dodecahedron with 8 vertices, defined by markers. From 3D marker coordinates, the partial volumes were calculated in function of time for each compartment. The coefficient of variation of the volume curve was used to represent the relative change in percentage of volume in each compartment over time. The coefficient of variation of the trunk volume was analyzed in different compartments for each subject and this value was compared among the four compartments. Considering that percentage does not show normal distribution, the coefficient of variation was normalized by arcsine transformation. The coefficient of variation was chosen as the variable in order to reduce the effects of anthropometric differences among subjects. Data normality was performed using the Lilliefors test. When the hypothesis of data normality was rejected, nonparametric tests were used. To compare the differences

between the coefficients of variation of the four thoracoabdominal compartments before and after training and to compare the differences between the values of total volume before and after training was applied the Wilcoxon test, considering a significance level of $p < 0.05$.

RESULTS AND DISCUSSION

Table 1 shows the results of the thoracoabdominal mobility before and after one year of wheelchair rugby training.

Table 1. Mean values and standard deviation of the coefficient of variation in the four compartments of the trunk (ST, IT, SA and IA) before and after one year of wheelchair Rugby training.

Compartments	Before(n=7)	After (n=7)	p
ST	1.08%±0.69	1.42%±0.81	0.04*
IA	1.49%±0.8	1.84%±1.19	0.27
SA	2.36%±1.46	2.74%±1.52	0.26
IA	3.78%±1.98	3.21%±1.06	0.41

No significant differences were observed when the compartments IA, SA and IA were analyzed. There was a significant increase of 31.4% in the average coefficient of variation of the ST compartment after the training period.

People with spinal cord injuries show changes in respiratory function, as the decrease in vital capacity, generating inefficient ventilation, increasing energy consumption, thus contributing to muscle fatigue^{3,4,5}, thus activities that promote improvement in respiratory function are indicated for this population. The results obtained by three-dimensional kinematic analysis showed that when comparing the pre and post training in wheelchair rugby significant increase in mobility in the ST compartment after training. This finding makes it also possible to infer that the ST was the trunk region that contributed the most to the increase in lung volume allowing a better understanding of the mechanism by which this increase occurred.

CONCLUSIONS

The study showed positive effects on thoracoabdominal mobility of individuals with tetraplegia after one year of training in wheelchair rugby and revealed a modified breathing pattern with an increased contribution of the Superior Thorax to the total volume during respiration.

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