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## INSPIRATORY MUSCULAR ACTIVATION DURING THRESHOLD LOADING IN HEALTHY INDIVIDUALS

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### SUMMARY

This study evaluated the involvement of the diaphragm and sternocleidomastoid muscle (SCM) in reaching load of 40% and 80% of maximal inspiratory pressure (MIP), using surface electromyography (EMG) in healthy subjects. Healthy men and women, in total of 13 individuals, with ages between 20 and 30 years. The threshold was performed for seven minutes with a load of 40% followed by a resting interval of 4 minutes, and then seven minutes with a load of 80%. The electrical signal of the inspiratory muscles was recorded during the initial 30 seconds and the last 30 seconds of the 7 minutes. At 40% of MIP, the diaphragm showed greater electric activity at both the beginning, ( $p=0.01$ ), and the end ( $p=0.02$ ), of the 7-minute period compared whit the ECM. At 80% of MIP, the SCM muscle greater EMG activity ( $p=0.01$ ). The diaphragm appears to have greater involvement at 40% of MIP compared with the ECM. While, in a load of 80% of MIP, the ECM muscle increases its electrical activity as the respiratory exercise period extends increases.

### INTRODUCTION

Inspiratory muscle strength and endurance have been shown to be reduced in a number of condition, as chronic obstructive pulmonary disease (COPD) and chronic heart failure (CHF) [1,2]. Studies have shown that inspiratory muscle training (IMT) results in improvement in inspiratory muscle strength, ventilatory response to exercise, recovery oxygen uptake, and quality of life of patients with CHF and inspiratory muscle weakness [3,4]. Lotters et al. [5], through meta-analysis have demonstrated that IMT is important in pulmonary rehabilitation programs for COPD.

Authors have suggested that the best IMT system still remains to be defined. Many are the factors that may interfere in the results, as the load level and respiratory pattern [5]. The charge level stipulated for training is still controversial. It is believed that the contribution of the respiratory muscles must change with use of different linear loads. This study evaluated the involvement of the diaphragm and sternocleidomastoid muscle (SCM) in reaching load of 40% and 80% of maximal inspiratory pressure (MIP), using surface electromyography (EMG) in healthy subjects.

### METHODS

Healthy men and women, in total of 13 individuals, with ages between 20 and 30 years. Had their MIP assessed with a digital manometer. MIP was considered the highest value of five measurements inspiratory loads were determined through the value of MIP, where 40% and 80% were used. IMT was held loading through linear threshold.

The threshold was performed for seven minutes with a load of 40% followed by a resting interval of 4 minutes, and then seven minutes with a load of 80%. Individuals were instructed to perform only diaphragmatic breathing during the seven minutes of each load imposed by the IMT device.

Surface electrodes captured the muscle electric signals. Placed in the seventh intercostal space, between the axillary line and middle clavicular line, for the diaphragm, and on the muscular body, 5 cm from the mastoid process, for the SCM. The electrical signal of the inspiratory muscles was recorded during the initial 30 seconds and the last 30 seconds of the 7 minutes.

The statistical analysis of the muscle electrical activity was performed for each load by the nonparametric Wilcoxon and Spearman correlation matrix. In this study, the electrical activity was presented by the RMS values from the normalized EMG recordings. Values were considered significant when  $P < 0.05$ .

### RESULTS AND DISCUSSION

At 40% of MIP, of the non-dominant side, the diaphragm showed greater electric activity at both the beginning, ( $p=0.01$ ), and the end, ( $p=0.02$ ), of the 7-minute period compared whit the ECM. This could be due to the prevalence of type I fibers, characteristic of the diaphragm, indicating suggesting that endurance exercises could be a more appropriated training to this muscle.

When submitted to a load of 80% of the MIP, there were no statistically differences in EMG activity between the diaphragm and SCM muscle. Yet also at 80% of MIP, the SCM muscle showed greater EMG activity ( $p=0.01$ ) at the

end compared with the beginning of exercise period in the non-dominant side. It could be explained by the fact that the SCM muscles are when the ventilator demand or the inspiratory effort increases.

Since the diaphragm is the main inspiratory muscle and its EMG activity increased at 40% of MIP, smaller loads could be more effective for inspiratory training. In patients with COPD, it seems that activation of accessory muscles happens with smaller loads when compared to normal elderly. With larger loads, the recruitment of accessory muscles just modifying the ventilator pattern of the individuals [6].

### CONCLUSIONS

The diaphragm appears to have greater involvement at 40% of MIP compared with the ECM. While, in a load of 80% of MIP, the ECM muscle increases its electrical activity as the respiratory exercise period extends increases.

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