Title: WORK OF BREATHING DURING EXPIRATORY THRESHOLD LOADING

Authors: E. Goldman, M.D., J. Road, M.D.*, A. Grassino, M.D.**

Affiliation: Department of Anesthesiology, The Ohio State University College of Medicine, N429 Doan Hall, 410 W. 10th Avenue, Columbus, OH 43210; *The Department of Medicine, University of British Columbia, Vancouver, Canada; **Meakins-Christie Laboratories, McGill University, Montreal, Canada

Introduction. The mechanical work of the respiratory muscles is often estimated by the product of pressure and volume during quiet tidal breathing. However, during augmented breathing this method may underestimate work[1]. The external work of breathing measured in this manner does not take into account work performed on the chest wall, on decompression of gas, or work done on the abdominal compartment. During augmented breathing, considerable respiratory muscle force and shortening may be performed in distorting the chest wall. With the technique of sonomicrometry, muscle shortening can be recorded. This technique provides an index of work previously unobtainable. The objectives of this study were to assess the work of breathing during augmented breathing induced by expiratory threshold loading (PEEP).

Methodology. Studies were performed on six supine dogs anesthetized with pentobarbital (25-30 mgs per kg). The airway was intubated with a number 8 endotracheal tube. Airflow was recorded at the tube opening and integrated to obtain tidal volume (Vt). Transdiaphragmatic pressure swings ($\triangle$pdi) were measured by the balloon catheter technique and taken as the algebraic sum of gastric and esophageal pressure swings. Diaphragmatic length changes were recorded by piezo electric transducers inserted in both parts (costal and crural) of the diaphragm. We previously described this technique of sonomicrometry which allows accurate measurements of diaphragmatic length changes[2]. During spontaneous tidal breathing a range of expiratory threshold loads (ETL) were randomly applied. Levels of ETL range from 4-20 cm H_2O.

Results and Discussion. During ETL tidal volume was defended. With an ETL of 20 cm H_2O, Vt was 81 $\pm$ 24% of control. The external work of breathing was derived as a function of $\triangle$ pdi and Vt and compared to the internal work derived from the $\triangle$ pdi and the changes in diaphragmatic length (%LFRC). ETL, as we have previously shown, increased the $\triangle$pdi required to produce Vt (Fig. 1). This increase in force is largely due to an increase in swings in pleural pressure as opposed to abdominal pressure (Fig. 1). Diaphragmatic shortening increased in both parts of the diaphragm (Fig. 2). As a consequence, diaphragmatic (internal) work increased five-fold compared to a two-fold increase in external work (Fig. 3). We conclude: (1) During expiratory threshold loading (PEEP) the work of breathing increases; (2) The work of breathing as estimated by tidal volume and transdiaphragmatic pressure swings markedly underestimates the actual work of breathing for the diaphragm; and (3) Previous estimates of the degree to which external work underestimates internal work need to be reevaluated in the assessment of intrinsic PEEP, expiratory and inspiratory loading.

References.

1. Jaeger MJ and Otis AB. Effects of compressibility of alveolar gas on dynamics and work of breathing. J Appl Physiol 19:83-91, 1964
2. Newman S, Road J, Bellemare F, Clozel JP, Lavigne CM and Grassino A. Respiratory muscle length measured by sonomicrometry. J Appl Physiol 56(3):753-764, 1984

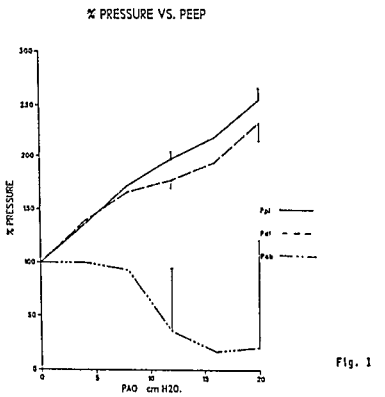

Fig. 1

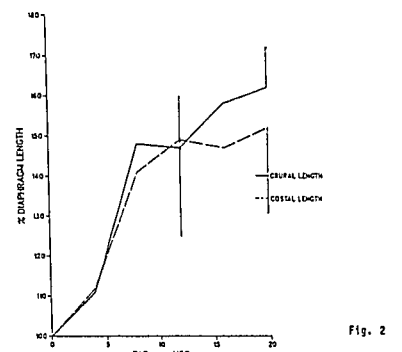

Fig. 2

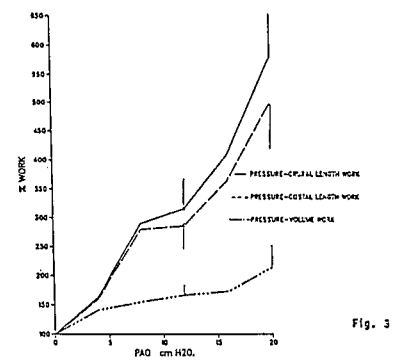

Fig. 3