Respiratory Responses to Graded Isocapnic Expiratory Threshold Loading in Humans

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Background and Purpose: In healthy human subjects, an expiratory threshold load (ELT) induces sustained hyperventilation. We hypothesized that, during ETL breathing, the ventilatory responses and abdominal expiratory activity would be greater if the ETL-related hypocapnia were prevented by maintaining the end-tidal PCO_2 ($PETCO_2$) isocapnic to near that during quiet breathing. Another purpose was to determine the effect of body position on these ETL responses. ***Methods:*** We studied 10 subjects who breathed against ETL without (CON) and with CO_2 added (ISO) in both supine and upright positions. ETLs were studied at 0, 5, 15 and 25 cm H_2O. Inspiratory (T_I), expiratory (T_E), and total cycle (T_{TOT}) durations, tidal volume (V_T), breathing frequency (F_b), minute ventilation (V_E), mean inspiratory flow rate (V_T/T_I), and mean expiratory flow rate (V_T/T_E) were determined from inspiratory flow recordings. Abdominal electromyograms (EMGs) were detected with surface electrodes placed over the internal (IO) and external oblique muscle (EO) regions. Times of onset (onset latencies), and duration of the EMG expiratory bursts were determined from raw EMGs; peak amplitudes of the EMG expiratory bursts were determined from the integrated EMGs. $PETCO_2$ was continuously recorded. ***Results:*** In response to ETL, $PETCO_2$ decreased during CON and was maintained isocapnic to quiet breathing (QB) level during ISO. During ISO, V_T, V_E, V_T/T_I, and V_T/T_E were significantly greater than those during CON in both body positions. Amplitudes and durations of the EMG expiratory bursts from EO and IO abdominal muscles were not different between CON and ISO but the onset latencies of these expiratory bursts during ISO were significantly shorter than those during CON. During either ETL conditions tidal volume (V_T), minute ventilation (V_E), peak amplitudes and durations of the abdominal EMG expiratory bursts were greater when the subjects were upright than supine. The onset latencies of the EMGs were shorter when the subjects were upright than when supine. ***Conclusion:*** We conclude that, during loaded ETL breathing, developing hypocapnia acts to compensate for this stress by preventing further CO_2-induced hyperpnea.(FJPT 2000;25(5):292-303)

Key words: Expiratory threshold loading (ETL), Isocapnic, Body position, Ventilatory responses, Control of breathing

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