

# THE EFFECT OF STATIC LUNG LOAD ON HEMODYNAMICS AND GAS EXCHANGE DURING PRONE IMMERSED EXERCISE AT 122 FSW

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## ABSTRACT

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INTRODUCTION: Static lung load (SLL) is the difference between mouthpiece pressure and lung centroid pressure. A previous investigation of 3 subjects at 190 fsw revealed that positive SLL increased expiratory reserve volume (Thalmann ED et al. Undersea Biomed Res 1979;6:259). We hypothesized that +SLL would increase respiratory deadspace and augment hypercapnia.  
METHODS: After institutional approval and informed consent 10 volunteers were studied during prone exercise while immersed in thermoneutral water at a simulated depth of 122 fsw breathing air. Each subject was instrumented with ECG and radial and pulmonary artery catheters. Cardiac output was calculated using the Fick method. Measurements were obtained during SLL 0, (0SLL), +10 cmH<sub>2</sub>O (+SLL) and -10 cmH<sub>2</sub>O (-SLL) in random order.  
RESULTS: Measurements are shown in the table (mean±SD).  
CONCLUSIONS: During immersed prone exercise, a static lung load of ±10 cmH<sub>2</sub>O did not significantly affect arterial PCO<sub>2</sub>, respiratory deadspace, cardiac output, heart rate or stroke volume.  
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## INTRODUCTION

Static lung load (SLL) is the difference between mouthpiece pressure and lung centroid pressure (Fig. 1). A previous investigation of 3 subjects at 190 fsw revealed that positive SLL increased expiratory reserve volume. Comparing -10 cmH<sub>2</sub>O to +10 cmH<sub>2</sub>O SLL, ERV increased on average from 28% to 43% of the control vital capacity (Fig. 2, Thalmann ED et al. *Undersea Biomed Res* 1979;6:259).

Fig. 1: Static Lung Load

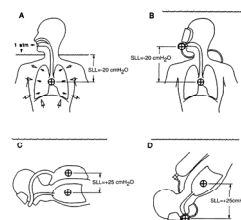
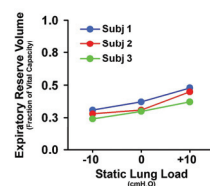


Fig. 2: Expiratory Reserve Volume vs SLL During Submaximal Exercise at 190 fsw



## HYPOTHESIS

We hypothesized that +SLL would increase respiratory deadspace and augment hypercapnia. In addition, we predicted that PaCO<sub>2</sub>-P<sub>ET</sub>CO<sub>2</sub> would increase with SLL.

## METHODS

Ten healthy volunteers were instrumented with radial and pulmonary artery catheters. At 122 fsw (4.7 ATA) in a hyperbaric chamber (Fig. 3) subjects were studied during prone immersed exercise at approximately 150 W total work breathing air (inspired PO<sub>2</sub> 1 ATA). Measurements included ventilation (V<sub>E</sub>), oxygen consumption (VO<sub>2</sub>), heart rate, arterial pressure, mean PAP, PAWP, cardiac output (Fick), end-tidal CO<sub>2</sub> (mass spectrometer), and arterial and mixed venous blood gases. Intravascular pressures were referenced to the lung centroid. It was assumed that intrapleural pressure was 1/2 times the SLL. Transmural pressures across the atria and pulmonary artery were therefore estimated as P-0.5xSLL. Statistical analysis was by repeated measures ANOVA.

## RESULTS

Complete data were obtained on 8 subjects. Measurements are shown in Table 1.

Table 1: Results

Condition	VO <sub>2</sub> (L/min)	PaO <sub>2</sub> (mmHg)	PaCO <sub>2</sub> (mmHg)	PETCO <sub>2</sub> (mmHg)	V <sub>E</sub> (L·min <sup>-1</sup> )	V <sub>E</sub> /V <sub>T</sub>
SLL 0	2.3±0.5	610±61	44±7	46±8	61.2±12.1	.27±.07
SLL +10 cmH <sub>2</sub> O	2.4±0.6	608±36	46±3	46±5	65.1±12.4	.32±.07
SLL -10 cmH <sub>2</sub> O	2.3±0.6	606±55	45±5	46±5	61.6±8.3	.27±.08

Condition	HR (min <sup>-1</sup> )	MAP (mmHg)	CVP (mmHg)	Mean PAP (mmHg)	PAWP (L·min <sup>-1</sup> )	CO (L·min <sup>-1</sup> )
SLL 0	141±21	114±12	-2±5	21±7	10±7	17.7±2.4
SLL +10 cmH <sub>2</sub> O	144±18	117±12	-1±7	23±10	13±10	18.2±2.3
SLL -10 cmH <sub>2</sub> O	141±19	110±8	-1±4	19±7	10±6	17.6±1.9

## CONCLUSIONS

During submaximal exercise at 122 fsw breathing air, static lung load of ±10 cmH<sub>2</sub>O is insufficient to affect respiratory or cardiovascular parameters. Preload is maintained during exercise despite the changes in SLL, possibly due to increased sympathetic tone.

## ACKNOWLEDGMENT

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