Can we use peripheral venous pressure (PVP) variability during leg raise test to predict hypovolemia during Lower body negative pressure?

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Introduction: The venous system is a low pressure highly compliant system that can accommodate large changes in volume with only minimal changes in pressure[1]. The impact of respiratory and cardiac pulse on PVP waveforms during hypovolemia can be isolated by frequency analysis and could identify hypovolemia before detectable hemodynamic changes[2]. During leg raise test (LRT) there is an auto-transfusion of 300 cc of blood from the lower limbs to the central circulation. Lower body negative pressure (LBNP) chamber creates a reversible hypovolemia by sequestrating blood in the lower extremities. There were 2 aims for this study: 1) To study the impact of LRT on PVP and 2) to determine whether the change in PVP during LRT may be used as a predictive tool to determine the tolerance to hypovolemia during LBNP.

Our hypothesis is that subjects who have low tolerance to LBNP induced hypovolemia will be associated with lower PVP and higher PVP variability during LRT.

Methods: With IRB approval 17 subjects underwent both LRT and LBNP. Each subject was monitored for heart rate (HR), continuous noninvasive arterial blood pressure (CNAP), PVP waveforms which were generated from a transduced upper extremity intravenous site and NICOM to measure cardiac output (CO). These parameters were measured at baseline, during LRT for 2 min and during progressive LBNP at -15 mmHg, -30 mmHg, -45 mmHg, -60 mmHg, -75 mmHg and -85 mmHg. Seven out of 17 subjects were excluded because of insufficient data or because LRT was not performed.

Based upon the development of symptoms of hypovolemia during LBNP, subjects who developed symptoms of hypovolemia at LBNP of -60 mmHg were classified as having low tolerance (LT) to LBNP and subjects who developed symptoms at LBNP lower than -75 mmHg or who did not develop symptoms were classified as having high tolerance (HT) to LBNP. The PVP variability was calculated using ∆PVP% = 100*(LRT value - baseline value)/baseline value. Results were reported as mean ± SD and paired t-tests of the means were used to determine the differences in PVP and ∆PVP% between HT and LT groups. In order to determine the ability of PVP variability during LRT to predict tolerance during progressive LBNP, a ∆PVP% ROC curve was made.

Results: During LBNP 5 out of 10 subjects were LT and 5 were HT. There were no significant differences in BP, HR and CO during LRT between groups. With LRT, there was a significant increase in the PVP. The average PVP values were 10 Â±4 and 17 Â±2 mmHg for LT and HT groups respectively (p <0.05), as shown in figure 1-A and 1-B. The ∆PVP% were 61Â±26 and...
21±16 for LT and HT subjects respectively (p < 0.05). The ROC curve of PVP variability at a cutoff point of ≥30% had a sensitivity of 100% and specificity of 60% as shown in figure 2.

Discussion: All LT subjects had a ΔPVP% ≥ 30%, while the HT group had variable values during LRT. These results support our theory that LT (hypovolemic) subjects had a more compliant venous system that can accommodate extra blood volume (≈300 cc) and show smaller values in the mean PVP (10 ±4 mmHg) and higher PVP variability during LRT (61±26).

On the other hand, HT subjects showed higher baseline PVP values, which indicated a full system. We noticed that during LRT, the average 300 cc of blood resulted in higher PVP values (17 ±2 mmHg) and lower PVP variability (less compliant system).

Conclusion: Changes in PVP during LRT could be useful as a measurement for the prediction of tolerance to LBNP induced hypovolemia.

References: