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. We were interested to study the impact of LRT on PVP and 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 progressive LBNP will be associated with lower PVP and higher PVP variability during LRT.

Methods: 17 subjects underwent LRT and LBNP. Each onewas monitored for heart rate (HR), CNAP, PVP waveforms and NICOM to measurecardiac output(CO)at baseline, during LRT for 2 min and during progressive LBNP at -15, -30, -45, -60, -75 and -85 mmHg. 7subjects were excluded because of insufficient data.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 did not develop symptoms, as having high tolerance(HT) to LBNP. The PVP variability was calculated using ΔPVP% =100*((LRT value – baseline value)/baseline value). Results were reported as mean±SD, t-test wasused to determine the differences in PVP and ΔPVP% between (HT) and (LT) groups.ROC curve of ΔPVP% was made to determine the ability of ΔPVP% during LRT to predict tolerance during progressive LBNP.

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

Discussion: All (LT) subjectshad a ΔPVP% ≥ 30%.(LT) group had lower meanPVPand higher ΔPVP% during LRT.(HT) group had higher PVP values at baseline and lower ΔPVP% during LRT. These results support our theory that (LT) subjects had a more compliant venous system.

Conclusion: PVP changes during LRT maybe a useful tool to be used for the prediction of tolerance to LBNP induced hypovolemia.

References:

1.Wardhan R, Shelley K. Peripheral venous pressure waveform; CurrOpinAnaesthesiol. 2009 Dec, 22(6):814-21.

2. Alian AA, Galante NJ, Stachenfeld NS, Silverman DG, Shelley KH. Impact of lower body negative pressure induced hypovolemia on peripheral venous pressure waveform parameters in healthy volunteers.Physiol Meas. 2014 Jul;35(7):1509-20.

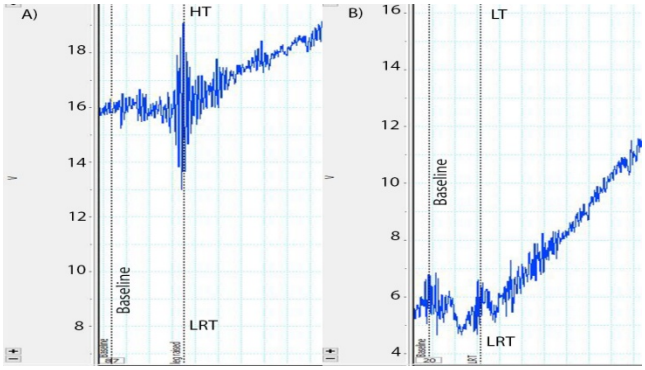

Figure 1. PVP tracing before and after LRT from (HT) subject (1-A) and (LT) subject (1-B).

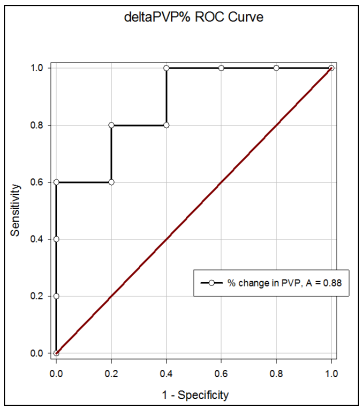

Figure 2: ROC curve of PVP variability, ΔPVP% ≥30% with sensitivity of 100% and specificity of 60%.