Title: IS SYSTOLIC BLOOD PRESSURE VARIATION A SENSITIVE INDICATOR OF HYPOVOLEMIA?

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The fluctuation of the arterial pressure due to intermittent positive pressure breathing is well known, and clinically it is thought that the systolic arterial pressure variation (SAPV) are more pronounced during hypovolemia. In a recent study[1] in dogs subjected to graded hemorrhage, SAPV was reported to serve as a sensitive indicator of hypovolemia as well as cardiac output (CO). In our institution, 500-1000 ml of blood is routinely withdrawn from patients undergoing coronary artery graft surgery (CAG) just prior to bypass and returned to the patients during the post-bypass period to minimize hemorrhagic diathesis. This gave us an opportunity to observe changes of SAPV and other hemodynamic parameters during blood withdrawal.

Methods: Under institutional approval, eight patients scheduled for elective CAG were included in this study. After insertion of radial and pulmonary artery catheter, anesthesia was induced with fentanyl 50 microg/kg and pancuronium 0.15 mg/kg. All pressure traces were continuously recorded in a 4-channel recorder. The analogue signals from the arterial pressure monitor were fed to an IBM-XT program written in Asyst (Rochester, N.Y.)[2] for power spectral analysis. Trends of power spectrum which include respiratory related variations (R-APV) were displayed on the monitor screen on the real time basis (Fig. 1). We also measured SAPV as the mean difference between the maximum and minimum systolic arterial pressure (SAP) during five consecutive breaths. Differences between maximum SAP and baseline SAP (up) and baseline miminum SAP (down) were also measured from the tracing record. When the patients were ready for bypass, 500-100 ml of blood were withdrawn from the vein during the 8-10 minute period. Blood pressures were initially supported by the infusion of neosynephrine drip and albumin were given toward the end of the blood withdrawal. CO were determined every minute during the blood withdrawal by thermodilution technique. Mixed venous oxygen saturation (SvO_2) and blood gases were also measured every minute.

Results: Table 1 shows the mean values (±SD) oof hemodynamic and SAPV related parameters obtained during period of the last 2-4 minutes of blood withdrawal (H) compared to the 4 minute period just prior to withdrawal of blood. There were significant ($P<0.05$) decreases in PCWP, cardiac index (CI) and SvO_2 following the blood withdrawal. The correlation coefficients between the amount of blood withdrawal and SvO_2 ($r=0.91\pm0.04$) were better between blood withdrawal and CI ($r=0.81\pm0.08$). There were no significant differences in all variables related to SAPV. Statistical analysis consisted of analysis of variance and linear regression.

Discussion: SvO_2 monitoring provided the most predictable index of the blood loss in the present protocol. Unfortunately, the parameters related to SAPV did not turn out to be a useful indicator of hypovolemia in this human study. There may be at least two reasons for this. (1) The pericardium was opened in the present study. When the pericardium was opened, we found changes of CVP due to positive pressure breathing (CVP) were less compared to that of PCWP (PCWP). Thus, the effect of positive pressure breathing on the venous return of the right heart might have been less compared to intact chest. This explains why the down components of SAPV were minimum. (2) Another reason would be a problem related to the measurement of SAPV. The measurement of SAPV presuppose that SAP is stationary. However, we found SAP were not stationary during blood withdrawal. We often observed low frequency fluctuations of arterial pressure occurred during blood withdrawal (Fig. 1-A) and in such intances we observed R-APV decreased (Fig. 1-B).

Conclusion: SAPV may not be a sensitive index of hypovolemia in humans when pericardium is open.

References:

1) Perel A, et al: Anesthesiology 67:498-502, 1987.

2) Komatsu T, et al: A system for automated spectral analysis of arterial blood pressure oscillation. Computer in Anesthesia VIII. Oct. 14-17, 1987. Lake Lanier Islands, Georgia.

Table 1

	C	H	P<0.05
SAP (mmHg)	104.3±11.1	88.7±13.0	NS
HR (beats/min)	69.6±8.8	70.7±9.3	NS
PCWP (mmHg)	6.7±2.9	4.7±1.5	*
CI ($l/min.m^2$)	2.4±0.5	1.6±0.5	*
SvO_2 (%)	72.3±5.7	57.6±5.6	*
PH	7.42±0.05	7.41±0.06	NS
AWP (mmHg)	11.0±2.4	11.0±2.4	NS
PCWP (mmHg)	3.9±1.8	3.7±1.5	NS
CVP (mmHg)	1.1±0.2	1.1±0.2	NS
SAPV (mmHg)	9.0±7.3	14.1±7.5	NS
Up (mmHg)	8.5±6.6	12.3±4.9	NS
Down (mmHg)	0.3±1.2	0.6±3.8	NS
R-APV ($mmHg^2$)	28.0±25.6	29.4±23.8	NS

Fig 1