Title: SYSTEMIC VASCULAR RESISTANCE NEEDS CORRECTION FOR HEMATOCRIT VALUES

Authors: T. Komatsu, M.D., V. Kumar, M.D., V. Sanchala, M.D. and K. Shibutani, M.D.

Affiliation: Department of Anesthesiology, New York Medical College - Westchester County Medical Center, Valhalla, New York 10595

Introduction: Estafanous et al reported systemic vascular resistance (SVR) is a critical determinant of intraoperative hemodynamics during coronary artery bypass graft (CABG) surgery.[1] SVR consisted of vascular component and viscosity component, accordingly interpretation of SVR can be misleading if proper correction is not made for blood viscosity changes during cardiac surgery where marked changes of hematocrit (HCT) occurs. We defined the vascular component of SVR as the Corrected Systemic Vascular Resistance (C-SVR) and expressed in the following Modified Vand equation:[2] $C\text{-}SVR = 0.41 \times SVR/(1+0.025\,(Hct)+0.000735(Hct)^2)$. C-SVR is independent of blood viscosity if temperatures and protein are within normal range and depends only on the size, shape and geometry of the vascular bed. The purpose of this study was to examine (1) whether C-SVR is a better index of hemodynamics than SVR and (2) the relationship between C-SVR and oxygen transport in patients undergoing CABG surgery.

Methods: Twenty-three patients with coronary artery disease who underwent CABG surgery were retrospectively studied. Age varied from 40 to 65. Most of the patients had been treated with beta receptor blocking agents. Anesthesia consisted of diazepam (0.3 to 0.5mg/Kg) and fentanyl (15 to 50mcrg/Kg), 50% N_2O/O_2 and pancuronium. All of the patients were monitored with EKG, radial artery and thermodilution pulmonary artery catheterization. During bypass, clear liquid priming, moderate hypothermia (27°C rectal) and roller pump with flow rate of 1.2-2.9 $l/min/M^2$ were used. Multiple hemodynamic variables were obtained before induction (C), after induction (S_1), after stenotomy (S_2), after cannulation (S_3) and after bypass at 15 mins (S_4), 30 mins (S_5), 60 mins (S_6), the end of operation (S_7). C-SVR and O_2 delivery (arterial oxygen content x cardiac index) were calculated.

Results: The changes of SVR and C-SVR were expressed as % of control value (C) (Fig. 1). I. Prebypass Period: There were significant increases in both SVR and C-SVR during prebypass period as compared to the control values. The increase of SVR and C-SVR were 105±41% and 201±72%, respectively at S_3. II. Postbypass Period: At the immediate postbypass period (S_4, S_5) both SVR and C-SVR decreased significantly from the prebypass value, but when compared to the control values, SVR decreased slightly (77%) but C-SVR increased to 145% of the control value. Both SVR and C-SVR gradually increased thereafter. At the end of operation (S_7) C-SVR increased to 214% of the control value, while SVR values were not significantly different from the control value. Mean Hct values during the study period were 44.1±2.7 at C, 41.2±3.8 at S_1, 40.2±3.6 at S_2, 37.4±5.0 at S_3, 22.5±2.4 at S_4, 22.2±3.0 at S_5, 22.8±3.0 at S_6 and 24.3±3.0% at S_7. Mean blood pressure did not vary significantly from the control except S_5 (88%) and S_6 (89%).

Throughout the study period, correlation was better between C-SVR and O_2 delivery ($y=1630.14 - 1.99x$, $n=135$, $r=-0.78$, $P<10^{-9}$, $Syx=190.34$) than between SVR and O_2 delivery ($y=3284.52 - 2.42x$, $n=135$, $r=-0.34$, $P<10^{-3}$, $Syx=819.91$).

Discussion: At the immediate postbypass period SVR was lower than the preinduction control value yet C-SVR was higher than the control. This finding suggests that the vascular beds were more constricted as compared to the preinduction state. If the lower than normal value of SVR was interpretted as an index of the dilated peripheral vascular beds, the misleading selection of pharmacological support may occur.

The excellent correlation between C-SVR and O_2 delivery suggests, C-SVR may be a better parameter to be considered to maintain adequate tissue oxygenation. If O_2 delivery is still inadequate after optimizing C-SVR, blood transfusion may be needed in addition to pharmacological support to improve oxygen transport to tissue.

References: (1) Estafanous FG: Hemodynamic patterns of coronary artery surgery - Role of systemic vascular resistance. Anes Anal 61:181, 1982. (2) Merril EW: Rheology of blood. Physiol Rev 49:863, 1969.

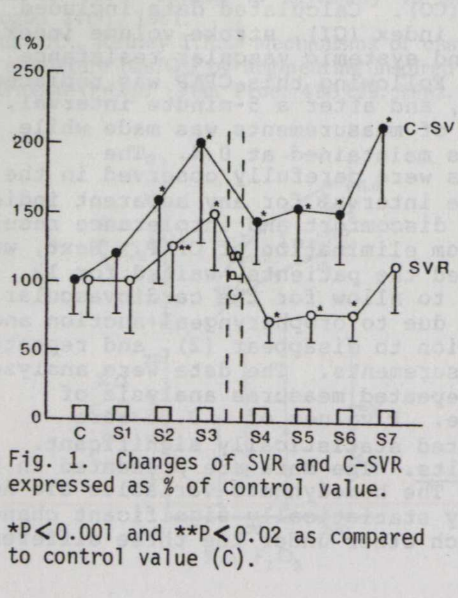

Fig. 1. Changes of SVR and C-SVR expressed as % of control value.

*P<0.001 and **P<0.02 as compared to control value (C).