Title : SENSITIVITY OF THE LEFT VENTRICLE TO OUTFLOW RESISTANCE

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INTRODUCTION: A review of changes in left ventricular (LV) function in 28 patients during anesthesia and major non-cardiac surgery has been undertaken to examine the premise that the normal LV is relatively afterload insensitive; that reduction of aortic impedance, of which arteriolar resistance is the major component, permits a dysfunctioning LV to empty more completely; and that the "more abnormal the function of the LV, the greater the stroke volume will rise as the arterial impedance is reduced."[1,2]

METHODS: All patients included in the study were awake and hemodynamically stable at the time of baseline measurements. Direct measurements included EKG, heart rate (HR); systemic arterial (SAP) right atrial and pulmonary artery occluded pressures; and cardiac output measured by thermal dilution technique. Derived measurements included stroke volume (SV, ml/beat), cardiac index (CI, ml/min/m^2), systemic vascular resistance (SVR, dynes sec cm^{-5}), and left ventricular stroke work index (LVSWI, gm-m/beat/m^2). Patients were assigned to one of three subsets of ventricular function on the basis of baseline values of LVSWI and SVR. Anesthesia was induced and maintained with a nitrous oxide, diazepam, narcotic, relaxant technique. From the values of SV (y) and SVR (x) a regression line ($y = ax + b$), correlation coefficient (r), and probability of significance (p) were determined.

RESULTS: Linear regression slopes relating SV and SVR in the patients studied could be determined with strong and significant correlation, all $r > 0.83$, all $p < 0.02$. Ventricles of patients with good LV function (Subset I, LVSWI >30, SVR <2000, 7 patients) were found to be load sensitive and in two cases the steep slope of the regression lines indicated marked sensitivity with $\Delta SV/1000\ \Delta SVR$ (ml change in SV per 1000 dynes sec cm^{-5} change in SVR) of 60 and 84 ml compared to a mean of 25.4 ± 4.3 ml for the other 5 patients of the subset. In 7 cases (Subset II, LVSWI >30, SVR >2000), slopes indicated load sensitivity and favorable prospect for vasodilator therapy. In 14 patients considered to have poor LV function (Subset III, LVSWI <30), sensitivity to change in SVR was not greater than in Subsets I and II. In 4 of the 7 patients the regression slopes were 6, 7.7, and 9 ml $\Delta SV/1000\ \Delta SVR$; these ventricles were much less sensitive to reduction of SVR and a steeper regression slope was obtained only with inotropic support. In one Subset III patient, $\Delta SV/1000\ \Delta SVR$ was 45 ml, a steep slope; LV function ceased shortly after aortic cross-clamping increased SVR.

DISCUSSION: In this study, linear regression slopes relating changes in SV and SVR were determined as an indication of LV function. The findings of the study are at some variance with conclusions of Cohn and others. Left ventricules with good LV function proved load sensitive during anesthesia and surgery, and in two such patients the regression slopes of SV vs SVR were steep. In patients with poor LV function there was a range of regression slopes. In patients with less steep slopes, SV was relatively fixed and changed little with increase or decrease of SVR; vasodilator therapy was of limited application and inotropic support sometimes required. At the other extreme of the range, a markedly steep regression slope indicated a hazardous sensitivity to change in SVR. These findings have important clinical implications for anesthesia management and indicate the value of regression slope analysis of SV vs SVR in clinical evaluation of LV function.

REFERENCES:

1. Cohn, J.N., Francisca, J.A.: "Vasodilator Therapy of Cardiac Failure." NEJM 297: 27-31, 1977.
2. Imperial, E.S., Levy, M.N., Zieske, H., Jr.,: "Outflow Resistance as an Independent Determinant of Cardiac Performance." Circ Res 9: 1148-1155, 1961.

Figure 1: Plot of regression slopes (SV vs SVR) of two patients of Subset III. Starred circles indicate baseline values for each patient. Upper slope: $r=0.95$, $p<0.001$, patient with load sensitive ventricle, larger values of SV obtained with vasodilator therapy. Lower slope: $r=0.85$, $p<0.001$, relative load insensitivity of LV, limited improvement in SV obtained with reduction in SVR.