

Title: RIGHT VENTRICULAR FUNCTION AFTER CARDIAC SURGERY: The effect of PaCO<sub>2</sub>

Authors: A. Viitanen, M.D., M. Salmenperä, M.D., and J. Heinonen, M.D.

Affiliation: Department of Anesthesia, Helsinki University Central Hospital, Haartmaninkatu 4, SF-00290 Helsinki, Finland

**Introduction.** After coronary artery bypass grafting (CABG) with cardiopulmonary bypass (CPB) even slight respiratory acidosis results in pulmonary vasoconstriction and rise in right ventricular afterload.<sup>1</sup> This study examines whether moderate respiratory acidosis has an effect on right ventricular function after CABG.

**Methods.** 18 CABG patients with good left ventricular function (ejection fraction 0.62±0.02) were studied according to the protocol approved by the Ethical Committee of the Institute. Anesthesia was with diazepam, high-dose fentanyl and pancuronium. Ventilation was with oxygen in air (FiO<sub>2</sub> 0.5), tidal volume of 8 mlkg<sup>-1</sup> and respiratory rate adjusted to achieve normocarbica at 5 cmH<sub>2</sub>O PEEP. Nonpulsatile CPB with bubble oxygenation and moderate hypothermia (28°C) was used. The control measurements were obtained in stabilized normocarbica about three hours after the end of CPB. Following this, hypocarbica and hypercarbica were induced by changing the respiratory rate keeping tidal volume constant. The sequence of hypo- and hypercarbica was randomly reversed. After this, the reversibility of the response was tested by producing again normocarbica. At each level of PaCO<sub>2</sub> heart rate (HR), mean artery pressure (MAP), mean pulmonary artery pressure (MPAP), pulmonary capillary wedge pressure (PCWP) and central venous pressure (CVP) were recorded. Cardiac output (CO), right ventricular ejection fraction (RVEF) and right ventricular end-diastolic volume (RVEDV) were determined using a Swan-Ganz thermodilution catheter with a rapid response thermistor and an ejection fraction/cardiac output computer (REF-1™, American Edwards Laboratories).<sup>2</sup> The Wilcoxon signed rank test was used to compare hemodynamic responses at induced PaCO<sub>2</sub> levels with control. Data are expressed as mean ± SEM. P < 0.01 was considered significant.

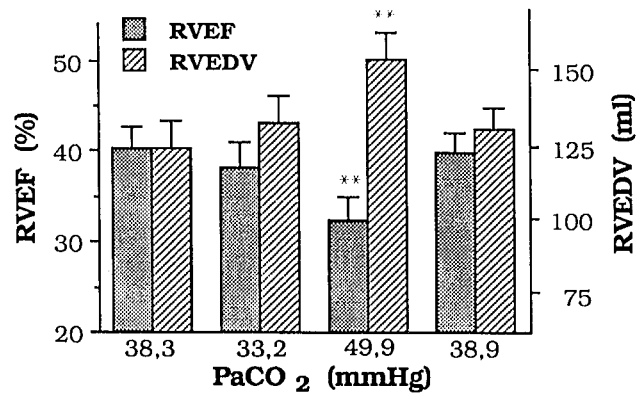
**Results.** (Table and Figure) In moderate respiratory acidosis MPAP significantly increased after CPB. This resulted in significant increases in RVEDV and CVP and decrease in RVEF while CO remained unchanged.

**Discussion.** Pulmonary vasoconstriction induced by moderate respiratory acidosis results in impaired right ventricular function in CABG patients recovering from CPB. This is indicated by decreased RVEF. For adequate forward stroke output extra right ventricular work is done through preload augmentation as reflected by increased RVEDV and CVP. Right ventricular failure may be precipitated in susceptible patients. Consequently, tight control of PaCO<sub>2</sub> is mandatory after cardiac surgery.

#### References.

- Salmenperä M, Heinonen J: Pulmonary vascular responses to moderate changes in PaCO<sub>2</sub> after cardiopulmonary bypass. *Anesthesiology* 1986;64:311-316.
- Kay HR, Afshari M, Barash P et al.: Measurement of ejection fraction by thermal dilution techniques. *J Surg Res* 1983;34:337-346.

**Figure.** Right ventricular ejection fraction (RVEF) and right ventricular end-diastolic volume (RVEDV) with varying levels of PaCO<sub>2</sub>. \*\* p < 0.001, compared to control.



Table

	PaCO <sub>2</sub> (mmHg)			
	Contr. 38.3 ±0.6	33.2 ±0.6	49.9 ±0.7	38.9 ±0.8
HR (bpm)	84.6 ±3.0	86.8 ±3.1	85.6 ±3.1	87.7 ±3.2
MAP (mmHg)	80.4 ±3.6	88.9* ±4.1	79.7 ±4.1	88.5 ±3.5
MPAP (mmHg)	18.1 ±0.8	17.2 ±0.7	24.2** ±0.6	19.1 ±0.8
CO (l min <sup>-1</sup> )	3.92 ±0.14	4.11 ±0.21	4.05 ±0.22	4.31 ±0.22
PCWP (mmHg)	8.3 ±0.6	9.0 ±0.5	9.2* ±0.5	9.0 ±0.5
CVP (mmHg)	7.1 ±0.5	7.6 ±0.6	8.6* ±0.5	7.8 ±0.6

\* p < 0.01, \*\* p < 0.001 ; compared to control.