Title: COMPARISON OF RIGHT VENTRICULAR FUNCTIONS BETWEEN HIGH FREQUENCY POSITIVE PRESSURE VENTILATION AND CONVENTIONAL VENTILATION IN CORONARY ARTERY BYPASS SURGERY

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Introduction. High frequency positive pressure ventilation (HFPPV) has been successfully used during anesthesia for laryngeal and thoracic surgery and bronchoscopy.[1] HFPPV has an advantage of providing adequate gas exchange and cardiovascular stability with significantly lower peak airway pressure over intermittent positive pressure ventilation (IPPV).[1] This decreased airway pressure with HFPPV may improve right ventricular filling and right ventricular function (RVF). This study was designed to compare hemodynamic effects, especially right ventricular function and respiratory parameters of HFPPV and IPPV in patients undergoing coronary artery bypass surgery (CABG). All patients were alternately ventilated with IPPV and HFPPV using the North American Dräger anesthesia ventilator.

Method. Six adult patients, age 41-64 years (mean age 56) undergoing elective CABG participated in the study which was approved by the institutional review board. Five patients had prior myocardial infarctions. Left ventricular ejection fractions were in the range between 39% and 65% (mean 55.7%). All patients were premedicated with morphine (0.1 mg/kg) and scopolamine (0.04 mg/kg). Anesthesia was induced and maintained with sufentanil, vecuronium, supplemental isoflurane (0.3-0.5%), and 100% oxygen.

Right ventricular fuction was assessed by a thermodilution ejection fraction/volumetric pulmonary artery catheter and American Edwards REF-1 computer.[2] Patients were first ventilated for a 15-min period with IPPV and switched to HFPPV for the next 15-min period before opening the chest in the prebypass periods. The same sequence of ventilatory modes were repeated after closing the chest in the postbypass period. All patients were ventilated with the ventilator of the North American Dräger anesthesia machine (Narkomed). This ventilator was used to provide tidal volume of 10 ml/kg, rate of 10/minute, I:E ratio of 1:2 and FiO_2 of 1 with IPPV mode and expiratory tidal volume less than 200 ml, rate of 70/min, I:E ratio of 1:3.5 and FiO_2 of 1 with HFPPV mode.

Because of compressible volume of the circle system, actual delivered tidal volume was much less than 200 ml with HFPPV. At the start and the end of 15-minute periods with IPPV and HFPPV, the following parameters were measured: cardiac index (CI), stroke volume index (SVI), right ventricular ejection fraction (RVEF), right ventricular end-diastolic volume index (RVEDVI), right ventricular end-systolic volume index (RVESVI), systemic and pulmonary vascular resistance indices (SVRI, PVRI), systemic and mean blood pressure (SBP, MBP), pulmonary capillary wedge pressure (PCWP), central venous pressure (CVP), A-a DO_2, pH, $PaCO_2$, PaO_2, PvO_2, and peak airway pressure (PAWP). Statistical analysis was carried out using analysis of variance and values were expressed as mean ± SD. $P < 0.05$ was considered significant.

Results. The results are shown in Table I. Peak airway pressures were significantly lower with HFPPV (11.3 ± 1.5, 12.8 ± 1.2) than with IPPV (20.3 ± 2.3, 23.3 ± 2.9) in both prebypass and postbypass periods ($p < 0.0001$). However, there were no significant differences in RVEF, RVEDVI, RVESVI, and SVI between IPPV and HFPPV. Not only were there no significant differences in other cardiovascular parameters such as SVRI, PVRI, BP, and PCWP, but also no differences in A-a DO_2, pH, $PaCO_2$, PaO_2, PvO_2 between IPPV and HFPPV in both prebypass and postbypass periods. SVI, RVEDVI, and PvO_2 in the postbypass periods differed significantly from the prebypass period in both IPPV and HFPPV modes ($p < 0.05$).

Discussion. HFPPV achieves effective alveolar ventilation with minimal cardiovascular interference.[1] This study showed that although HFPPV groups showed significantly lower peak airway pressure, there was no significant improvement of right ventricular function or PVRI with HFPPV over IPPV during the prebypass and postbypass periods in patients undergoing CABG.

There were no significant differences in other cardiovascular parameters, ventilation, and oxygenation between IPPV and HFPPV in prebypass and postbypass periods. All patients were ventilated adequately with IPPV and HFPPV. HFPPV with the ventilator of this North American Dräger anesthesia machine (Narkomed) can be used to ventilate patients with coronary artery disease satisfactorily by providing adequate pulmonary gas exchange and cardiovascular stability when needed.[3,4]

TABLE I

	Pre-Types		Post-Types	
	CPPV 2A	HPPV 2A	IPPV 2B	HPPV 2B
CI	2.61 ± 0.52	2.68 ± 0.36	2.90 ± 0.60	2.67 ± 0.24
RVEF	0.54 ± 0.09	0.54 ± 0.08	0.48 ± 0.12	0.47 ± 0.07
SVI	46.2 ± 5.5	50.0 ± 9.0	28.8 ± 9.6	30.5 ± 8.4
REVDI	87.2 ± 14.6	46.5 ± 28.4	64.0 ± 18.1	60.2 ± 16.2
RVESVI	41.0 ± 13.3	46.5 ± 21.1	35.3 ± 15.3	29.5 ± 10.0
SBP	125 ± 22	132 ± 20	114 ± 9	117 ± 7
MBP	79.5 ± 9.5	83.5 ± 13.9	81.2 ± 11.1	82.5 ± 7.4
MPA	14.2 ± 4.8	14.8 ± 5.8	19.8 ± 4.3	17.5 ± 5.3
PCWP	10.0 ± 4.4	10.1 ± 5.6	14.0 ± 5.0	11.3 ± 4.8
CVP	4.8 ± 2.6	5.7 ± 5.4	9.6 ± 4.5	7.7 ± 4.8
SVRI	2336 ± 515	2308 ± 341	2020 ± 449	2385 ± 588
PVRI	133 ± 84	118 ± 50	175 ± 67	197 ± 178
A-a DO_2	265 ± 48	234 ± 60	283 ± 183	293 ± 165
pH	7.46 ± 0.04	7.43 ± 0.04	7.46 ± 0.02	7.42 ± 0.04
$PaCO_2$	33.6 ± 4.7	37.4 ± 5.5	30.3 ± 2.2	35.0 ± 4.9
PaO_2	415 ± 50	443 ± 58	397 ± 183	385 ± 165
PvO_2	48.8 ± 5.4	48.5 ± 5.6	38.5 ± 7.9	40.2 ± 3.8
PAWP	20.3 ± 2.3	11.3 ± 1.5	23.3 ± 2.9	12.8 ± 1.2

All values are mean ± SD.

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