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Title : NITROGLYCERIN: EFFECTS OF VENTRICULAR FUNCTION AND BYPASS

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Introduction. Myocardial oxygen demand ($M\dot{V}O_2$) is frequently elevated during coronary artery bypass surgery (CABG). Intravenous nitroglycerin (NTG) has previously been shown to be effective in reducing $M\dot{V}O_2$ in a series of 20 patients with good left ventricular function (LVF) undergoing CABG[1], but has not been studied in patients with poor LVF. In addition, NTG is often used to control blood pressure on cardiopulmonary bypass (CPB). The purposes of this study were to: (1) compare the effectiveness of NTG in patients with good versus poor LVF; and (2) measure the response to NTG while on CPB.

Methods. 40 patients scheduled for elective CABG gave written informed consent for the study which was approved by the Human Investigations Committee. 23 patients had good LVF (EF > .5 and LVEDP < 15 torr); 7 patients had poor LVF (EF < .5 and LVEDP > 15 torr); and 10 patients were intermediate between these two groups. The 7 patients with poor LVF all had a history of congestive heart failure and were taking digitalis. Propranolol was taken by 88% of the patients. All patients were anesthetized with morphine (1 mg/kg), diazepam (0.3 mg/kg), 50% N_2O/O_2, and pancuronium. Radial artery and thermodilution pulmonary artery catheters were placed in all patients. ECG leads II and V_5 were recorded, and the rate pressure product (RPP=SBP x HR) and triple index (TI=SBP x HR x PCWP) were used to estimate $M\dot{V}O_2$. NTG was administered in the prebypass period for the following indications of increased $M\dot{V}O_2$: (1) Systolic blood pressure > 160 torr; (2) PCWP > 18 torr; (3) RPP > 12,000; (4) TI > 150,000; or (5) ST segment depression > 1mm. While on CPB, NTG was given for a mean arterial pressure > 100 torr. NTG was begun at 50 ug/min and increased to a maximum dose of 400 ug/min. Measurements were made before starting NTG and after each dose had been given for 5 minutes.

Results. 38 patients required NTG in the prebypass period for one or more of the indications. Systolic hypertension or an elevated TI were the most common indications for NTG. The average effective dose of NTG (dose normalizing all indications for NTG) was 110±10 ug/min. NTG lowered systolic, diastolic, and mean pressures, PCWP, CVP, RPP, and TI in a dose-related manner ($P<.01$). Heart rate increased significantly only at the highest dose. Cardiac output and systemic and pulmonary vascular resistances changed minimally. $M\dot{V}O_2$ decreased in 95% and myocardial ischemia (ST segment depression) improved in 77% of the patients. The hemodynamic response in the patients with good versus poor LVF is shown in the table. The control value is compared to the maximum effective dose for each group. There were no statistically significant differences between the control values of the two groups; the responses to NTG of the two groups; or the response of either of these groups compared to all patients studied. While on CPB, only 67% of 18 patients responded to NTG and only at a much higher effective dose of 230±40 ug/min. The mean arterial pressure decreased from 107±4 to 99±3 torr at peak effect on CPB at constant flow and temperature.

Discussion. NTG normalized all measurements of increased $M\dot{V}O_2$ in 87% of the patients, and all but a single variable in the remaining 7 patients. The systolic pressure was the most difficult indication of $M\dot{V}O_2$ to reduce with NTG in these patients. The drug was equally effective for reducing $M\dot{V}O_2$ in patients with good and poor LVF, but surprisingly a larger dose of NTG was needed in patients with poor LVF. Hempelman[2] previously reported that NTG was effective in controlling blood pressure on CPB. However, we found that NTG, primarily a venodilator, was less effective during CPB when arteriolar dilatation is required to decrease mean arterial pressure and peripheral resistance. The dose-response relationship for control of the blood pressure was much weaker on bypass than in the prebypass period.

References.

(1) Kaplan JA, Dunbar RW, Jones EL: Nitroglycerin infusion during coronary artery surgery. Anesthesiology 45:14, 1976.

(2) Hempelman G, Pipenbrock S, Seitz W, et al: Changes in hemodynamic parameters due to nitroglycerin. J Thorac Cardiovasc Surg 73:836, 1977.

TABLE

HEMODYNAMIC EFFECTS OF NTG

	GOOD LVF		POOR LVF	
	CONTROL	NTG	CONTROL	NTG
Dose		105±13[1]		150±15†
MAP	117± 4	94± 2**	123± 8	100± 7**
HR	64± 2	66± 2	69± 5	71± 4
PCWP	17± 1	10± 1**	18± 2	10± 2**
CI	2.4±.1	2.3±.1	2.3±.3	2.3±.2
RPP (10^2)	107± 5	85± 3**	120±11	100± 8*
TI (10^3)	180±13	81± 6**	215±23	95±16**

1. $\bar{X}$±SE

2. *=P < .05; **=P < .01 from control; †=P < .05 compared to dose in good LVF group.