

Title : AFTERLOAD REDUCTION AND PRELOAD AUGMENTATION

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Introduction. The amount of regurgitant flow through an insufficient cardiac valve is largely dependent upon the afterload. During anesthesia, surgical stimulation increases vascular resistance and decreases forward cardiac output. Afterload reduction has therefore become part of our anesthetic management when ventricular failure develops from valvular regurgitation. However, vasodilators also decrease preload, and cardiac output is maximized only when preload is simultaneously augmented. This combined therapy is begun before induction of anesthesia and continues during anesthesia and surgery until cardiopulmonary bypass. Thus, during this stressful period, regurgitation is minimized and forward ventricular emptying is promoted.

Methods. Data were collected from 17 such cases. Prior cardiac catheterization had revealed mitral regurgitation (7 patients), aortic regurgitation (7 patients) or both lesions (3 patients) and sufficient congestive heart failure to warrant valve replacement. Preoperative medications had included digitalis and diuretics, and recent rapid weight loss had been encountered in 7 patients. Premedication consisted of morphine and scopolamine. Monitoring included an EKG, an arterial line and a triple-lumen thermodilution Swan-Ganz catheter. In the OR a baseline hemodynamic profile was obtained, i.e., heart rate, arterial pressure, central venous pressure, left ventricular filling pressure, cardiac index, stroke volume index and systemic vascular resistance index. Following these control measurements, but prior to anesthesia, a nitroprusside infusion was started slowly and then gradually increased over 45 minutes. Simultaneous rapid administration of Ringer's lactate solution prevented hypotension. This combined therapy was titrated to decrease vascular resistance while maintaining filling

pressures at or above control. At this point a second hemodynamic profile was recorded and with both infusions still running morphine 0.5-1 mg/kg, diazepam 5-10 mg and metocurine 30-40 mg were given over 15 minutes and the patients were intubated and ventilated with O₂ alone or O₂ and 50% N₂O to a PaCO₂ of close to 40 torr. A third hemodynamic profile was obtained just before incision and a fourth after the median sternotomy.

Results. Awake preanesthetic control measurements demonstrated that these patients came to surgery with low cardiac and stroke volume indices of 2.2 L/min/m² and 30 ml/beat/m² respectively, and a high systemic vascular resistance of 38 units. Although left ventricular filling pressure was 20 torr, central venous pressure was not elevated. Combined therapy decreased vascular resistance to 19 units with little change in filling pressures. Cardiac index increased 42% and stroke volume 35%. Repeat hemodynamic profiles during anesthesia and during surgery revealed that vascular resistance remained low, filling pressures were still high and cardiac and stroke volume indices measured above 3.1 L/min/m² and 40 ml/beat/m² respectively. No significant change in heart rate occurred during the course of therapy, and arterial hypotension was rarely encountered. The hematocrit fell from a preoperative mean of 40% to 26% on bypass. Urinary output was ample and fluid overload did not occur, even though the mean weight gain on the day of surgery was 3.4 kg.

Conclusions. We conclude that the combination of afterload reduction and preload augmentation improves the anesthetic management of patients with valvular regurgitation and ventricular failure, and we believe this combined therapy should begin prior to anesthesia and should continue throughout surgery.

Hemodynamic profiles at four measurement periods (N = 17)

	Awake Control	Awake	Anesthesia	Anesthesia and Surgery
Nitroprusside Infusion ($\mu\text{g}/\text{kg}/\text{min}$)	-	2.2 \pm 0.3	1.3 \pm 0.1	3.7 \pm 0.6
Cumulative Fluid Infused (liters)	-	1.8 \pm 0.1	3.2 \pm 0.2	4.0 \pm 0.2
Heart Rate (beats/min)	78 \pm 4	82 \pm 4	76 \pm 4	81 \pm 4
Mean Arterial Pressure (torr)	86 \pm 4	75 \pm 3	66 \pm 3	76 \pm 3
Vascular Resistance Index (units)	38 \pm 3*	19 \pm 2	19 \pm 1	23 \pm 1
Stroke Volume Index (ml/beat/m ²)	30 \pm 3*	46 \pm 3	41 \pm 2	40 \pm 3
Cardiac Index (L/min/m ²)	2.2 \pm 0.1*	3.8 \pm 0.3	3.1 \pm 0.2	3.2 \pm 0.2
Left Ventricular Filling Pressure (torr)	20 \pm 2	21 \pm 2	19 \pm 1	17 \pm 2
Central Venous Pressure (torr)	5 \pm 1	8 \pm 1	10 \pm 1	7 \pm 1

Values represent Mean \pm SE: * Control different from all succeeding measurements; P<0.001 (paired t test)