Title: EXPERIMENTAL USE OF VOLUME EXPANSION, ISOPROTERENOL AND COMBINED THERAPY DURING CARDIAC TAMPONADE

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Introduction. Temporary improvement of the deranged hemodynamics found in acute severe pericardial tamponade have been produced both in the experimental and clinical situation with volume expansion, beta-agonists, and vasodilatory agents, alone and in various combinations. However, the combination of volume expansion and isoproterenol infusion has not been evaluated. The purpose of this study was to compare the effects of volume expansion, isoproterenol infusion and a combination of the two treatment modalities on the hemodynamics of acute severe pericardial tamponade.

Method. Five dogs (weighing 18.2 - 25.6 kg) were anesthetized with sodium thiopental, paralyzed with pancuronium bromide, intubated and ventilated (IPPV) using a Harvard large animal ventilator. A Swan-Ganz catheter was placed via the left external jugular vein for measurement of cardiac output (CO), mean pulmonary artery occlusion pressure (MPAOP) and mean right atrial pressure (MRAP). Right femoral artery and veins were cannulated for measurement of mean arterial pressure (MAP) and volume infusion respectively, and a catheter tipped micromanometer was positioned in the left ventricle via the left femoral artery for continuous measurement of mean left ventricular pressure (MLVP) and left ventricular contractility (dP/dt) determination. A 1.5 mm I.D. silastic catheter was positioned in the pericardial sac via a left lateral thoracotomy for measurement of pericardial pressure (PP) and intrapericardial volume infusion. Baseline control measurements were taken after the dog had stabilized (approximately 30 minutes). Pericardial tamponade was induced by injecting homologous blood diluted 3:1 with heparanized saline intrapericardially until the CO was reduced to 32% of control. After a 30 minute stabilization period, baseline tamponade measurements were recorded. An IV infusion of isoproterenol 0.25 ug/kg/min was started and after the HR maximized (approximately 10 minutes) measurements were recorded. The infusion was discontinued and the animal was again allowed to stabilize. The animal was next given two IV volume infusions with Dextran70 6% (10 ml/kg each) and measurements were taken 10 minutes after each volume infusion was completed. Immediately after the second volume infusion, an infusion of isoproterenol 0.25 ug/kg/min was started and after the HR maximized, final measurements were taken. Statistical significance was established by a two-way analysis of variance followed by the Dunnett t-test with alpha splitting to reduce the chance of a type 1 error.

Results. The hemodynamic changes induced by pericardial tamponade and the responses induced by the treatment modalities are shown in the table. The significant changes from the tamponade baseline levels were as follows: The isoproterenol infusion increased the HR, CO, SV and the maximum positive dP/dt and decreased the MAP, MRAP and the SVR; volume expansion with Dextran70 6% 10 ml/kg increased the MRAP only; volume expansion with Dextran70 6% 20 ml/kg increased the MAP, MPAOP and MRAP while it decreased the SVR; the isoproterenol/Dextran70 6% 20 ml/kg combination increased the HR, CO, SV, the maximum positive dP/dt, MRAP and MPAOP while the MAP and SVR decreased. Intergroup statistical analysis revealed statistically significant differences in all the hemodynamic parameters except CO.

Discussion. Since definitive therapy for patients with pericardial tamponade is often delayed, interventions designed to stabilize hemodynamics may be required. The most commonly recommended intervention is volume infusion. While inotropic agents have demonstrated effectiveness in improving hemodynamics in animals and humans with pericardial tamponade, no study has been done evaluating the combination of inotropic support and volume loading. This study demonstrates greater improvements in stroke volume resulting from volume expansion and isoproterenol infusion than volume infusion alone. Isoproterenol and volume expansion results in a reduction in afterload and improvement in cardiac output towards control and may be beneficial to patients with cardiac tamponade.

References.

1. Fowler NO, Gabel M: Hemodynamic effects of isoproterenol and norephinephrine in acute cardiac tamponade. J Clin Invest 48:502-507, 1969

2. Triester B, Gianelly RF, Cohn KE, et al: The circulatory effects of isoproterenol, acetylstrophonthidin and volume loading in acute pericardial tamponade. Cardiovasc Res 3:229-305, 1969

3. Millard RW, Fowler NO, Gabel M: Hemodynamic and regional bloodflow distribution responses to dextran, hydralazine, isoproterenol and amrinone during experimental cardiac tamponade. J Am Coll Cardiol 1(6):1461-1470, 1983

TABLE

Parameter	Control	Tamponade	Isoproterenol	Volume	Volume plus Isoproterenol
HR (beats/min)	163 ± 43	157 ± 43	192 ± 37 *b	145 ± 32	183 ± 38 *b
CO (L/min)	3.45 ± 0.85	1.10 ± 0.28°	2.64 ± 0.73*	1.75 ± 0.42	3.36 ± 1.30*
SV (ml/beat)	23.2 ± 9.96	9.46 ± 4.40°	14.4 ± 5.60*	13.8 ± 6.50	19.6 ± 9.20*b
MAP (mmHg)	141.8 ± 20.2	113.4 ± 20.9°	88.2 ± 27.5*b	126.5 ± 20.7*	93.0 ± 27.6*b
MRAP (mmHg)	2.40 ± 2.68	8.20 ± 2.77°	5.0 ± 2.55*b	20.8 ± 5.60*	15.4 ± 5.60*a
MPAOP (mmHg)	1.50 ± 2.10	6.80 ± 2.70°	3.70 ± 3.50*b	16.6 ± 1.50*	17.8 ± 1.10*a
Max(+)dP/dt (mmHg/sec)	1663 ± 79.0	1111 ± 128 °	2891 ± 234 *b	1067 ± 229	2616 ± 326 *b
SVR (dynes•sec/cm^5)	3480 ± 1360	7376 ± 2240°	2744 ± 1360*b	5102 ± 1760*	2140 ± 1016*b

°Significant $p < 0.05$ as compared with control

*Significant $p < 0.05$ as compared with tamponade

[a]Significant $p < 0.017$ as compared with isoproterenol

[b]Significant $p < 0.017$ as compared with volume