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Title : PRESERVATION OF VENTRICULAR COMPLIANCE USING HYPOTHERMIC CARDIOPLEGIA

Authors : D. T. Mangano, Ph.D., M.D., D. C. Van Dyke, M.D., P. A. Ebert, M.D., and R. J. Ellis, M.D.

Affiliation: Departments of Anesthesia, Nuclear Medicine, Surgery, University of California, San Francisco, California 94143, and Veterans Administration Medical Center, San Francisco, California 94121

Introduction. Preserving myocardial function during cardiopulmonary bypass can significantly affect ventricular diastolic and systolic performance after discontinuation of bypass and throughout the immediate postoperative period. As such, the effects of preservation techniques are important to the anesthesiologist, who is involved with patient care during those critical times. Without myocardial preservation, significant decreases in left ventricular compliance occur within 45 min of ischemic arrest in the normothermic isolated heart. Attempts to reduce ischemia and associated decreases in compliance have led to the use of hypothermic potassium cardioplegia in the majority of cases. However, the acute intraoperative effects of hypothermic cardioplegia on ventricular compliance have not been studied in man. Thus, the efficacy of this method of presentation is still in question. We examined whether hypothermic cardioplegia preserves left-ventricular compliance in ischemic arrest lasting from 30 to 80 min.

Methods. With informed consent and approval of the Committee on Human Research, we studied 21 patients scheduled for coronary artery surgery. Preoperative ejection fractions ranged from 0.50 to 0.84. No patient had valvular disease or significant dyssynergy. Anesthesia consisted of morphine sulfate (1.5 to 3 mg/kg iv) and diazepam (0.25 to 0.50 mg/kg iv). Ventilation (with 100% oxygen) was controlled. Ejection fraction was determined with a co-axial cardiac scintillation probe using 1.5 mCi of ^{99m}TC-HSA. Cardiac output was determined using thermodilution. Following pericardiotomy, the sternum was temporarily reapproximated, surgery was stopped, and end-expiratory measurements were made while the patient was supine, and with the lower extremities elevated 90°. During bypass, a cold (4 C) cardioplegic solution containing either 5 or 20 mEq/l of K^+ was infused into the aortic root until myocardial temperature was reduced to 13 C. Then additional solution was given to maintain myocardial temperature below 20 C. In addition, systemic hypothermia at 28 C was maintained during the period of ischemic arrest, which ranged from 30 to 80 min. After bypass, the above hemodynamic measurements were repeated before and after 1500 ml of whole blood was transfused. Myocardial compliance was calculated as the ratio of the change in left-ventricular end-diastolic volume to the change in pulmonary capillary wedge pressure.

Results. Compliance improved in 18 patients, did not change in one patient, and decreased in two patients. Overall compliance increased from 7.6 ml/torr (± 1.8) to 14.3 ml/torr (± 3.2). The effects of the length of ischemic arrest on changes in compliance are shown in Table 1 and Figure 1.

Discussion. Previous studies in the isolated heart have demonstrated that within 45 min, ischemic arrest markedly decreases left-ventricular compliance. Our study in man demonstrates that these deleterious effects can be avoided by using hypothermic potassium cardioplegia. Furthermore, compliance is preserved even when ischemic arrest lasts 60 min or more. Thus, hypothermic potassium cardioplegia is of significant value for preserving left-ventricular function in patients undergoing ischemic arrest lasting up to 60 min.

Table 1. Ischemic Arrest and Myocardial Function

Duration of Ischemic Arrest (min)	Vessels By-passed (n)	Preop EF	Ventricular Compliance (ml/torr) Pre-Bypass	Ventricular Compliance (ml/torr) Post-Bypass	CPK (IU) at 24 Hr
< 45	2.4 (±0.4)	68.8 (± 3.4)	9.8 (± 5.9)	17.0 (± 8.8)	587 (± 229)
45 to 60	3.3 (±0.2)	68.1 (± 4.4)	10.5 (± 3.5)	16.1 ± 3.1)	293 (± 32)
> 60	3.4 (±0.2)	64.5 (± 3.3)	4.0 (± 0.9)	12.2 (± 3.3)	719 (± 155)

All values are mean ± SE.
EF = ejection fraction; CPK = creatine phosphokinase.

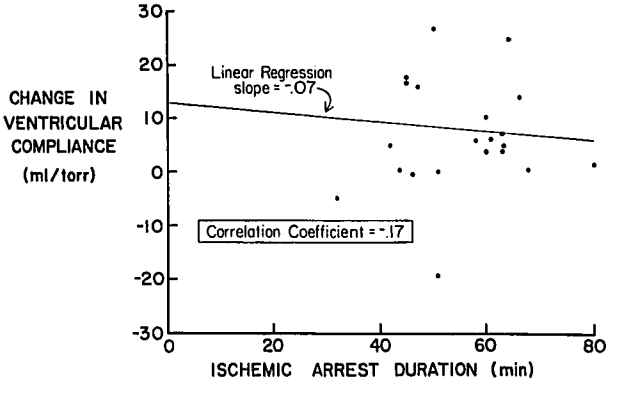

Fig. 1. Effect of duration of ischemic arrest on ventricular compliance.