

TITLE: INTRAVENOUS CALCIUM FAILS TO AUGMENT CARDIAC OUTPUT FOLLOWING CARDIAC SURGERY

AUTHORS: R.A. Strickland, M.D., L.J. Mark, M.D., J.F. Butterworth, IV, M.D., and G.P. Zaloga, M.D.

AFFILIATION: Department of Anesthesia, Wake Forest University Medical Center, Winston-Salem, NC 27103

Introduction. Intravenous administration of calcium (Ca) has multiple effects upon the cardiovascular system (1). Ca may increase cardiac output by increasing contractility and may increase systemic vascular resistance through direct arteriolar constriction. Ca is often administered to patients in the perioperative period in the belief that it will raise cardiac output and/or blood pressure. This study examines the responses of patients recovering from open heart surgery to a bolus and infusion of Ca chloride.

Methods. Following approval of the study protocol by our institutional review board and signing of informed consent by the patients, 14 extubated patients recovering from open heart surgery were enrolled in the protocol. All patients retained their pulmonary and radial artery catheters which had been inserted as a part of their anesthetic management. No patient received a vasoactive drug within 2 hours of our study. Measurements of glucose, potassium (K), ionized Ca (Ca_i) and hemodynamic values (heart rate (HR); mean arterial pressure (MAP); central venous pressure (CVP); mean pulmonary artery pressure (MPAP); pulmonary capillary wedge pressure (PCWP); and thermodilution cardiac outputs (CO)) were recorded at baseline and repeated after 20 mins of each of 2 infusions, a placebo or Ca. The infusions were administered in either order, separated by a 15 minute rest period. The placebo consisted of a bolus injection and infusion of 5% dextrose in water (D5W); the Ca consisted of a bolus injection of 1.25-2.5 mg/kg elemental Ca (i.e., 5-10 mg/kg $CaCl_2$) followed by an infusion of 0.5 mg/kg/hr elemental Ca.

Potassium and Ca_i determinations were accomplished using ion-selective electrodes. Glucose was measured using the glucose oxidase method. Data are presented as mean \pm SE and were analyzed using analysis of variance for repeated measures.

Results. The effects of either Ca or placebo administration upon hemodynamic values and serum Ca_i are indicated in Table 1. Ca significantly raised MAP, primarily due to a concurrent rise in SVR. Ca had no effect upon CO, CVP, PCWP, MPAP, HR, K or glucose. D5W (placebo) had no significant effect on any parameter measured.

Discussion. We were unable to demonstrate any salutary effect of an acute (roughly 20%) rise in Ca_i upon cardiac output in normocalcemic adult patients recovering from open heart surgery. Ca

administration in these patients did cause an acute rise in MAP which in a few patients resulted in a decrease in CO and a probable decrease in oxygen delivery.

In our initial protocol, we administered Ca as a 5 mg/kg bolus followed by a 0.5 mg/kg/hr infusion (a dose recommended by standard textbooks) (2). We found that this dose frequently induced nausea, and sometimes vomiting and chest discomfort. We subsequently reduced the bolus to 1.25-2.5 mg/kg, which resulted in similar circulating Ca_i levels 20 minutes post injection.

We warn against the indiscriminate use of Ca as a method of increasing CO in normocalcemic patients, since this agent more often increases SVR without increasing CO. The net result may be a decrease in oxygen delivery with increased cardiac work and increased myocardial oxygen demand.

We suggest that Ca therapy be limited to patient populations in which its efficacy is apparent: documented ionized hypocalcemia, calcium blocker overdose, and patients recovering from a hyperkalemic insult (e.g., cardioplegia).

TABLE 1
Effects of Calcium or Placebo
Following Cardiac Surgery

	CO L·min ⁻¹	MAP mm Hg	SVR dynes·sec·cm ⁻⁵	Ca_i mM
Placebo				
Before	5.04 \pm 3	86 \pm 2	1256 \pm 76	1.1 \pm .02
After	5.03 \pm 3	86 \pm 2	1258 \pm 70	1.1 \pm .03
Calcium				
Before	5.26 \pm 2	85 \pm 2	1150 \pm 56	1.1 \pm .02
After	5.18 \pm 3	91 \pm 2+	1301 \pm 99*	1.3 \pm .04+

*P<0.05

+P<0.005

References.

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2. Kaplan JA: Treatment of perioperative left heart failure. In: Kaplan JA, ed. *Cardiac Anesthesia*, 2nd ed, vol 2. Grune & Stratton, Orlando, p. 981, 1987