

Title: IONIZED CALCIUM LEVELS AND CALCIUM CHLORIDE ADMINISTRATION DURING WEANING FROM CARDIOPULMONARY BYPASS

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**Introduction.** In cardiac surgical procedures, hypocalcemia is often observed during the course of cardiopulmonary bypass (CPB). Bolus doses of calcium chloride (CaCl<sub>2</sub>) are frequently administered to patients shortly before weaning from CPB to correct this deficit. Our recent retrospective analysis of plasma ionized calcium levels ([Ca<sup>++</sup>]) during this period indicates that the amount of CaCl<sub>2</sub> usually given produces significant hypercalcemia (↑Ca<sup>++</sup>).<sup>1</sup> To provide the inotropic support of a normal [Ca<sup>++</sup>], and to avoid the potential hazard of ↑Ca<sup>++</sup> in reperfused myocardium, a CaCl<sub>2</sub> dosing regimen to optimize calcium replacement is desirable. This study was undertaken to examine [Ca<sup>++</sup>] during weaning from CPB.

**Methods.** 29 adult patients undergoing a cardiac surgical procedure with CPB and aortic cross clamp (AoX) were studied. Induction and maintenance of anesthesia were carried out according to the needs of the individual patient. Arterial blood pH and [Ca<sup>++</sup>] were measured within 15 minutes of separation from CPB (PRE). After warming the patient to a core temperature of at least 36° C., a bolus of CaCl<sub>2</sub> between 11.2 and 24.1 mg/kg (DOSE) was given into the CPB reservoir at a constant rate over one minute. CPB flow was greater than 2 L/min/m<sup>2</sup> at the time of the CaCl<sub>2</sub> bolus. Arterial blood samples were drawn at 1, 2, 5, 10, and 20 minutes following completion of the bolus for pH and [Ca<sup>++</sup>] determination. No additional CaCl<sub>2</sub> or citrated blood products were given during the study period. Statistical analysis utilized Student's T-test for paired data.

**Results.** The figure shows mean [Ca<sup>++</sup>] values. For analysis, DOSE was separated into 3 levels - Low: <14 mg/kg, Mid: 14-18 mg/kg, High: >18 mg/kg. Similarly, PRE [Ca<sup>++</sup>] values were labelled as either low (<1.0 mMol/L) or normal (1.0-1.3 mMol/L). No patients had PRE [Ca<sup>++</sup>] >1.3 mMol/L. Acute severe ↑Ca<sup>++</sup> (↑Ca<sup>++</sup>ac) was defined as [Ca<sup>++</sup>] >1.6 mMol/L at 2 min, and sustained ↑Ca<sup>++</sup> (↑Ca<sup>++</sup>sus) as [Ca<sup>++</sup>] >1.3 mMol/L at 20 min. The table lists the frequencies of ↑Ca<sup>++</sup>ac and ↑Ca<sup>++</sup>sus in relation to grouping of PRE [Ca<sup>++</sup>] and DOSE. No patient developed ↑Ca<sup>++</sup>ac or ↑Ca<sup>++</sup>sus if DOSE was Low. Moreover, if PRE [Ca<sup>++</sup>] was low, neither Low nor Mid DOSE resulted in ↑Ca<sup>++</sup>ac or ↑Ca<sup>++</sup>sus. At the end of the study period only 1 patient had a low [Ca<sup>++</sup>] (0.96 mMol/L). pH showed a small but significant decline during the study period (7.45 → 7.41, p <.002).

**Discussion.** Hypercalcemia may contribute to myocardial reperfusion damage.<sup>2</sup> Thus, avoiding ↑Ca<sup>++</sup> after AoX should be a goal of CaCl<sub>2</sub> administration during weaning from CPB. Wide variance in [Ca<sup>++</sup>] was observed during our study at the first minute following CaCl<sub>2</sub> dose. We felt that this was due to incomplete mixing in the blood volume and changes in regional blood flow and temperature. In addition, decreasing pH observed during this period may have influenced [Ca<sup>++</sup>]. However, neither immediate nor sustained hypercalcemia was observed when CaCl<sub>2</sub> dose was restricted to either <14 mg/kg in patients whose prebolus [Ca<sup>++</sup>] was

>1.0, or to <18 mg/kg when the prebolus [Ca<sup>++</sup>] was <1.0. Our findings suggest: 1) Patients' [Ca<sup>++</sup>] should be monitored on CPB in order to optimally dose CaCl<sub>2</sub>. 2) Carefully planned administration of CaCl<sub>2</sub> can reliably correct the hypocalcemia frequently observed during CPB without causing [↑Ca<sup>++</sup>].

**References.**

1. Stanley TE, Calcium channel blockers and calcium administration during weaning from cardiopulmonary bypass, *Anesth Analg* 66:S166, 1987.
2. Nayler WG, The role of calcium in the ischemic myocardium. *Am J Pathol* 102:262, 1981.

Figure. [Ca<sup>++</sup>] Disposition  
mean ± SE

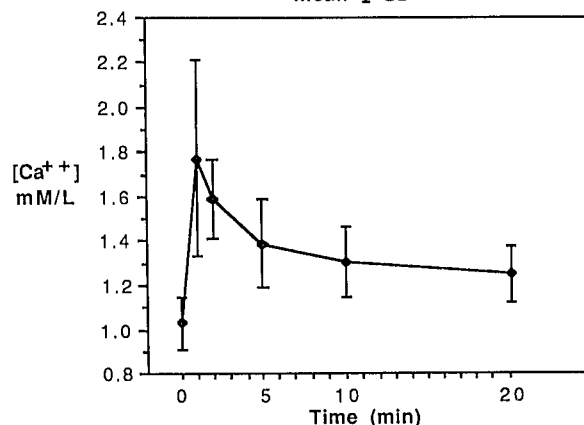


Table. Frequency of Hypercalcemia (# of patients)

		↑Ca <sup>++</sup> ac		↑Ca <sup>++</sup> sus	
		Absent	Present	Absent	Present
Dose <sub>lo</sub>		1	0	1	0
	Pre <sub>lo</sub>	7	0	7	0
	Dose <sub>hi</sub>	2	3	4	1
Dose <sub>lo</sub>		2	0	2	0
	Pre <sub>nl</sub>	6	4	6	4
	Dose <sub>hi</sub>	1	3	2	2
TOTAL		19	10	22	7