TITLE: A COMPARISON OF THE EFFECTS OF CENTRAL VS. PERIPHERAL BOLUS INJECTIONS OF POTASSIUM CHLORIDE ON AORTIC ROOT POTASSIUM CONCENTRATIONS IN SWINE

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INTRODUCTION: Bolus injections of potassium chloride(KCl) may be used clinically to treat hypokalemia or ongoing potassium loss during anesthesia. However, peripheral venous(PER) injections of concentrated KCl solutions (e.g. 2 mEq/cc) may lead to sclerosis of the veins and pain on awakening. For that reason, central venous(CVP) injections may be preferred. Although Tanaka et al. have studied the effects of peripherally administered KCl on aortic root(AR) potassium concentration($[K^+]$) in dogs(1),the present study was undertaken to compare the effects of PER vs. CVP administration of a clinically relevant bolus dose of KCl on the AR $[K^+]$ and the electrocardiogram(EKG) in swine.

METHODS: Four healthy pigs (approx. 24kg) were sedated with intramuscular ketamine and allowed to breathe 4% halothane.Following endotracheal intubation, the pigs were given pancuronium and ventilated with halothane and O_2 to obtain a normal end tidal CO_2. A cannula was inserted into the aortic root via the left carotid artery and a 5 Fr thermodilution pulmonary artery(PA) catheter was placed from the left internal jugular vein.The EKG was monitored continuously(lataeral chest lead). Following recording of baseline arterial blood gases,serum$[K^+]$, and cardiac output(CO), 33 micro-equivalents(uEq)/Kg of KCl was injected rapidly as a bolus either peripherally (ear vein) or centrally (CVP port of PA catheter).This dose was chosen to correspond to a clinically relevant dose in a 60 Kg patient(i.e. 2 mEq/60 kg). AR samples were collected every 3-6 seconds for between 30 and 90 seconds following the KCl injections and each injection was followed by a 15 min waiting period. In each animal, 6 separate injections were made, 3 CVP and 3 PER. During the experimental sequence, end tidal(ET) halothane was varied from 0.5% to 2% in an attempt to produce a range of cardiac outputs in each animal. Initial $[K^+]$, time from injection to peak AR $[K^+]$, and the maximum change in AR $[K^+]$ (Delta $[K^+]$) were compared between CVP and PER groups with unpaired t-tests. In addition, Delta $[K^+]$ was correlated with cardiac output using simple linear regression analysis.

RESULTS: AR $[K^+]$ data were obtained following 6 KCl injections in all 4 pigs.The initial $[K^+]$ was the same for the PER and CVP injections. The time from injection to the peak AR $[K^+]$ was significantly less following CVP injection compared to PER injection and the change in AR [K+] from baseline to the peak(Delta$[K^+]$) was significantly greater after CVP injection compared to PER injection(Table 1).Figure 2 demonstrates typical AR $[K^+]$ following both CVP and PER injections. Delta $[K^+]$ following CVP but not PER injection correlated significantly with cardiac output(Figure 1).There were no EKG or hemodynamic changes observed in any animal despite transient AR [K+] in excess of 7mEq/L in many of the animals.

DISCUSSION: These data demonstrate that clinically relevant centrally injected bolus doses of KCl(33 uEq/Kg) cause significantly greater elevations of AR $[K^+]$ than identical bolus doses given peripherally. Furthermore, the Delta$[K^+]$ following CVP injection is inversely related to cardiac output. Although no EKG evidence of hyperkalemia was seen in these animals, it is possible that their relatively greater ratio of cardiac output to body weight compared to humans may have contributed to this tolerance to bolus KCl administration. Therefore, although CVP bolus injections of KCl(e.g. 2 mEq/60 Kg) would appear safe, greater caution should be exercised in using this treatment modality in patients in low output states.

TABLE 1	CVP(Mean±SD)	PER(Mean±SD)
INITIAL $[K^+]$(mEq/L)	4.0±.5	3.8±.3
TIME TO PEAK $[K^+]$(sec)	21±5	29±9.6*
DELTA $[K^+]$(mEq/L)	3.1±1.0	2.27±.74*

* Denotes significant difference between CVP and PER($p < 0.05$ corrected unpaired t-test).

REFERENCES: 1. Tanaka K, Pettinger WA: Pharmacokinetics of Bolus Potassium Injections for Cardiac Arrhythmias. Anesthesiology V 38, No 6, June 1973 587-589.

FIGURE 1

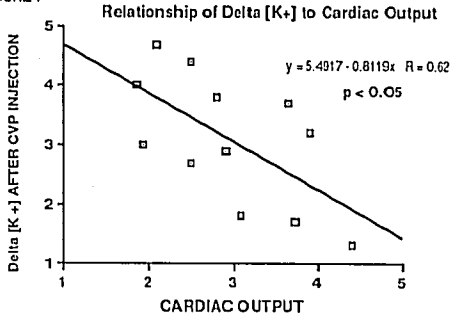

FIGURE 2