TITLE: THE EFFECT OF HYPERTONIC SALINE ON INTRACRANIAL PRESSURE, CEREBRAL BLOOD FLOW AND BRAIN WATER CONTENT

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Hypertonic saline (HTS) has been advocated for volume replacement (1), and can restore intravascular volume more rapidly than isotonic crystalloids. However, before HTS is employed for trauma resuscitation in patients with head injuries, the effects of such hyperosmolar solutions on the brain must be evaluated.

METHODS: 12 rabbits were anesthetized with thiopental (50mg), intubated, paralyzed and ventilated with 0.5% halothane/50% N_2O. Catheters were inserted to monitor arterial and rt. atrial pressures (BP and RAP), and a second arterial catheter was placed to allow blood removal. The head was then fixed in a stereotactic frame, and a 21 gauge needle was inserted into the cisterna magna for intracranial pressure recording (ICP). A platinum needle electrode (0.7mm diam) was inserted 2.5mm into the rt parietal cortex, via a 2mm burr hole, for the measurement of CBF (H_2 clearance). Wound margins were then infiltrated with 0.25% bupivicaine. 30 min later, baseline data were obtained [BP, RAP, ICP, CBF, P_aO_2, $PaCO_2$, pH and hematocrit (Hct)] and blood was drawn for later analysis of Na^+, K^+ and osmolality. In 6 animals, blood withdrawal was then begun at a rate of 1-2ml/min, and continued for 1 hr. During this time, HTS (Na^+ 252 mEq/l, 480 mOsm/kg) was infused at a rate sufficient to keep BP and RAP at baseline levels. This resulted in a progressive, isovolemic hemodilution (IVH), with a reduction in Hct from 41±1% to 20±1% (mean±SD). 6 animals served as controls and were not hemodiluted. They received lactated Ringer's solution, 4ml/kg/hr for 1 hr. At the end of the 1 hr period, data were again recorded and the animal was killed by exsaungination. The brain and samples of spinal cord (SC) and skeletal muscle (SkM) were removed. The H_2O content of SC and SkM and the right cerebral hemisphere (RCH) was determined by drying. The left cerebral hemisphere (LCH) and a SC sample were placed in cold (4°C) kerosene and 9 15-20mg samples were removed from various brain areas (see table 2). The specific gravity (SpGr) of each sample was measured with a microgravimetric technique, using a kerosene-bromobenzene density gradient (2). Note: as H_2O content increases, SpGr will fall (and vice versa).

RESULTS: There were no changes in the control group during the 1 hr period. There were no differences between values in the control group and baseline values in the HTS group (Table 1). IVH with HTS resulted in increases in Na^+, Osm and CBF. However, ICP decreased, as did H_2O content in the RCH, SC and SkM (Table 2). SpGr increased in all tissue regions examined.

CONCLUSION: In this IVH model, the administration of HTS lead to several changes which might prove beneficial during the resuscitation of a trauma victim with associated neurologic injuries. These included a reduction in ICP and brain H_2O content, coupled with an increase in CBF.[2] If these changes can be confirmed in brain injured animals, they would indicate a promising role for HTS in future trauma resuscitation.

REFERENCES:

1. Shackford SR, Sise MJ, Fridlund PH, et al.: Hypertonic sodium lactate versus lactated Ringer's for intravenous fluid therapy. Surgery 94:41, 1983.

2) Nelson SR, Mantz ML, Maxwell JA: Use of specific gravity in the measurement of cerebral edema. J Appl Physiol 30:268, 1971.

Table 1: HTS Hemodilution

	Baseline	1 hr
BP (mmHg)	92±7	79±14
ICP (mmHg)	2.1±1.1	0.2±0.8*
CBF (ml/100gm/min)	51±11	80±25*
Na^+ (mEq/l)	140±4	158±6*
Osm (mOsm/kg)	282±4	320±5*

Legend: Data for HTS animals (n=6) before (baseline) and upon completion of the 1hr IVH protocol. *=p < 0.05, paired t-test.

Table II: Water Contents

	Control	HTS
Wet-Dry (% H_2O)		
RCH	78.63±0.20	77.73±1.11*
SC	66.69±0.60	65.82±1.30*
SkM	74.85±0.43	73.81±0.69*
Micrograv (LCH)		
Cortex	1.0429±0.0000	1.0443±0.0008*
White	1.0421±0.0010	1.0431±0.0005*
Thal	1.0429±0.0010	1.0444±0.0008*
Hippoc.	1.0423±0.0005	1.0434±0.0007*
SC	1.0358±0.0015	1.0371±0.0004*

Legend: H_2O content and SpGr data at the end of the 1hr experimental period for the control and HTS-IVH groups (n=6 each). *p= < 0.05, unpaired t-test. Note: Cortex and white matter SpGr data are composites of 3 samples from each rabbit.