Effects of Infusion of Hypertonic Mannitol on Electrolyte Balance and on Osmolarity of Serum and Cerebrospinal Fluid*

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Intravenous infusion of hypertonic solution of mannitol has been shown to be effective in lowering cerebrospinal-fluid pressure and decreasing the mass of brain,1,11,17,18 as well as lowering intraocular pressure.13 In addition, mannitol is said to be effective in preventing renal damage2,3,9 and treating dilutional hyponatremia.5 Because of the increasing use of this substance, it is important to understand its effect on fluid and electrolyte balance, particularly in the postoperative patient.

The studies of osmolarities were done to elucidate the mechanism of action of mannitol in lowering cerebrospinal-fluid pressure.

Methods

The concentrations of sodium and potassium in serum and urine were determined by flame photometry with a lithium internal standard. The preoperative blood sample was drawn on the day prior to operation, or on the morning of the first postoperative day. An indwelling urinary catheter was inserted immediately after the induction of anesthesia; urine from the bladder was discarded then and urine was collected during the next 24-hour period ("operative day"). Osmolarity was determined by the method of freezing-point depression.†

The amount and type of intravenous fluids administered to these patients varied, since the surgeon in charge of each case determined the intake of fluid. Most neurosurgical patients at this hospital receive at least 75 mEq. of sodium on the operative day.15

Results

In 18 patients who received hypertonic solution of mannitol (1.1 to 3.6 gm./kg.) during operation the mean urinary volume on the operative day was 2840±863† mm. per 24 hours. In 17 of these, the mean urinary output of sodium was 94±56 mEq.; excluding patients with pituitary or hypothalamic lesions there were 12 patients with a mean output of sodium of 77±37 mEq. (Fig. 1). (The patients with pituitary or hypothalamic lesions received gluco-corticoid supplementation.) Six patients who did not receive mannitol had a mean operative-day excretion of sodium of 44±17 mEq.

In 16 patients who received mannitol the mean operative-day urinary excretion of potassium was 80±30 mEq. Excluding pituitary and hypothalamic lesions the mean excretion of potassium was 74±31 mEq. The mean value for 3 patients who did not receive mannitol was 55 mEq.

Both preoperative and postoperative concentration of serum sodium was determined in 17 patients who received mannitol during the operative procedure (Fig. 2). Mean preoperative concentration of serum sodium was 141.3±4.2 mEq. per l.; mean postoperative concentration of serum sodium was 144.1±6.7 mEq. per l. Excluding patients with lesions of the pituitary and hypothalamus, the respective mean concentrations were 139.9±2.7 mEq. per l., and 142.1±5.2 mEq. per l. in 12 patients. In 8 additional patients the preoperative concentration of serum sodium had not been determined, but the mean postoperative concentration of serum sodium was 140±3 mEq. per l. In 10 patients who did not receive mannitol the preoperative and postoperative concentrations of serum sodium were respectively 139.5±3.4, and 137.9±2.7 mEq. per l.

Concentration of serum potassium

† Standard deviation.
dropped slightly postoperatively whether or not mannitol was administered (Fig. 2).

Osmolarity Studies

In 4 patients simultaneous measurements of cerebrospinal-fluid pressure and serum and determinations of osmolarity of cerebrospinal fluid were performed before, during and after infusion of mannitol. (Some inaccuracy was introduced necessarily in the measurements of pressure by the need to remove samples of cerebrospinal fluid periodically for determinations of osmolarity.) Two patients had malignant gliomata and had undergone craniotomy 3 and 5 weeks previously. In the first patient (Fig. 3) infusion of 8 gm./kg. of mannitol in 65 min. increased osmolarity of serum 33 mOsm. and osmolar-