

Title : EFFECT OF INCREASED INTRACRANIAL PRESSURE ON CEREBRAL O₂ CONSUMPTION

Authors : J.E. Backofen, M.D., R.C.Koehler, Ph.D., M.D. Jones, M.D., R.J. Traystman, Ph.D., M.C. Rogers, M.D.

Affiliation: Department of Anesthesiology/Critical Care Medicine, Johns Hopkins Medical Institutions, Baltimore, Maryland 21205

Introduction: The effects of increased intracranial pressure (ICP) on cerebral blood flow (CBF), cerebral cortical oxygen consumption (\dot{V}_{O_2}), and cerebral fractional oxygen extraction (E) were studied in newborn lambs.

Methods: Newborn lambs (3 to 10 days of age) were anesthetized with pentobarbital, paralyzed with pancuronium, and ventilated to maintain constant arterial blood gases. ICP was elevated by infusion of mock CSF over two minutes into a catheter placed in the right lateral ventricle. ICP was then maintained at a constant level by means of a CSF reservoir connected to the ventricular catheter. CBF was measured with the radiolabelled microsphere technique. Reference blood flow samples were taken by constant pump withdrawal from a catheter in the brachiocephalic artery. A sagittal sinus catheter was used for cerebral venous blood samples. Cerebral cortical oxygen consumption was calculated using the cerebral arteriovenous difference of oxygen content and CBF. Fractional extraction was obtained as the ratio of cerebral oxygen consumption to cerebral oxygen delivery. Measurements were taken at baseline, and after 5, 15 and 40 minutes of elevated ICP.

Results: In one group of lambs (n=8) moderate elevation of ICP to a cerebral perfusion pressure (CPP) of 48 ± 2 mm Hg (+ SE) produced a small increase in cerebral fractional oxygen extraction that was statistically significant at 5 min (Table I). There were no significant changes in CBF or \dot{V}_{O_2} . In a second group of lambs (n=8) severe elevation of ICP to a CPP of 22 ± 2 mm Hg at 5 min and 26 ± 3 mm Hg at 15 and 40 min, was associated with a decrease in CBF at all times. Cerebral fractional oxygen extraction increased significantly as noted in Table II. There were no significant changes in \dot{V}_{O_2} .

Discussion: With moderate elevation of ICP to a CPP of 48 mm Hg, CBF is maintained. Thus cerebral blood flow autoregulation in the face of elevated ICP is intact in the newborn lamb down to perfusion pressures of at least

50 mm Hg. At a lower CPP of 26 mm Hg, CBF decreases. However, cerebral cortical oxygen consumption in the newborn lamb is maintained by an increase in cerebral fractional oxygen extraction at this level of CPP. Therefore a substantial O₂ extraction reserve exists to maintain O₂ uptake at perfusion pressures well below the lower limit of cerebral blood flow autoregulation.

Table I. Effect of Moderate Elevation of ICP

(* = p<.05 from control) (mean \pm SE) (n=8)

	Control	5min	15min	40min
ICP mmHg	10 \pm 2	36 \pm 4	35 \pm 6	37 \pm 4
MABP mmHg	84 \pm 4	85 \pm 4	86 \pm 7	84 \pm 5
CPP mmHg	74 \pm 4	48 \pm 1	52 \pm 2	48 \pm 2
CBF ml/min/100g	63 \pm 5	56 \pm 8	58 \pm 9	68 \pm 6
\dot{V}_{O_2} ml/min/100g	3.65 \pm .3	3.52 \pm .44	3.61 \pm .4	3.61 \pm .2
Extraction	.48 \pm .03	.57 \pm .03*	.53 \pm .04	.53 \pm .0

Table II. Effect of Severe Elevation of ICP (n=8)

	Control	5min	15min	40min
ICP mmHg	7 \pm 2	63 \pm 5	64 \pm 5	63 \pm 5
MABP mmHg	86 \pm 5	86 \pm 5	89 \pm 5	89 \pm 4
CPP mmHg	78 \pm 6	22 \pm 2	26 \pm 3	26 \pm 3
CBF ml/min/100g	53 \pm 6	37 \pm 5*	37 \pm 4*	37 \pm 4
\dot{V}_{O_2} ml/min/100g	3.44 \pm .31	3.44 \pm .28	3.31 \pm .33	2.87 \pm .1
Extraction	.51 \pm .05	.72 \pm .05*	.66 \pm .04*	.64 \pm .06*