Title: BRAIN SURFACE PROTRUSION DURING ENFLURANE, HALOTHANE AND ISOFLURANE ANESTHESIA IN CATS

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Introduction: Anesthetic drugs which increase the volume of the intracranial contents can produce elevations of ICP (closed cranium) or protrusion of the brain into the surgical field during craniotomy. The latter limits surgical access and increases the risk of retractor induced ischemia or mechanical damage. To compare the effects of the three common inhalation agents on the volume of the intracranial contents, the authors measured brain surface protrusion during acute equi-MAC exposures of enflurane (E), halothane (H), and isoflurane (I).

Methods: Eighteen cats were anesthetized with 4% H, paralyzed (pancuronium), intubated, ventilated and maintained with 1% H and 75% N_2O. The head was secured in a stereotaxic frame (sphinx position). An extensive standardized, unilateral craniotomy was made and the dura was excised. Brain surface protrusion was measured with a non-contact displacement transducer mounted on the stereotaxic frame. Outward movement was measured in mm relative to control position. Blood pressure (BP), central venous pressure, temperature (kept at 37°C), end-tidal (ET)CO_2 and ET inhalation agent concentration were monitored continuously. After surgical preparation, wound margins were infiltrated with 0.25% bupivicaine and H was discontinued. After a 90 minute H washout, the volatile agent under study was introduced. The ET concentration was elevated to the desired level within 2 minutes and maintained for a total of 5 minutes. Volatile anesthetic exposures were made at 0.5,1.0, and 1.5 MAC in random sequence. A 45 minute washout between phases assured a pre-exposure ET concentration of less than 0.05%. To correct for anesthetic induced changes in BP, a final study was performed in each cat at the 1.0 MAC level with angiotensin given to support BP.

Results: H produced significantly ($p<.05$) greater protrusion of the brain surface than did equi-MAC concentrations of I at all levels and greater protrusion than E at 1.0 and 1.5 MAC (Fig.1). When anesthetic induced differences in BP were eliminated by pressure support, the disparity between the protrusion caused by H vs E and I was exaggerated (Fig.2). At similar BP's, H produced 2.4 times as much protrusion as E ($p<.001$) and 2.6 times as much as I ($p<.001$).

Discussion: Our data indicate that E and I cause markedly less bulging of the brain into a craniotomy than does H. This finding probably reflects differences in anesthetic induced changes in cerebral blood volume. Anesthesia with E or I should result in an easier surgical exposure and lower retractor pressures. Our data also indirectly (since we did not measure CBF) suggest that H produces more impairment of autoregulation than either E or I. A comparison of the bulging observed with and without BP support at the 1.0 MAC level reveals that the additional protrusion resulting from a given pressure increment (i.e. Δ protrusion/Δ BP) was greatest for H and comparable for E and I.

Inhalation agents offer certain advantages in neurosurgery. High FIO_2's can be employed and elimination is largely independent of metabolism. Our results suggest that if an inhalation agent is to be employed in neuroanesthesia, E or I are preferable to H in terms of their effects on intracranial volume and perhaps autoregulation.

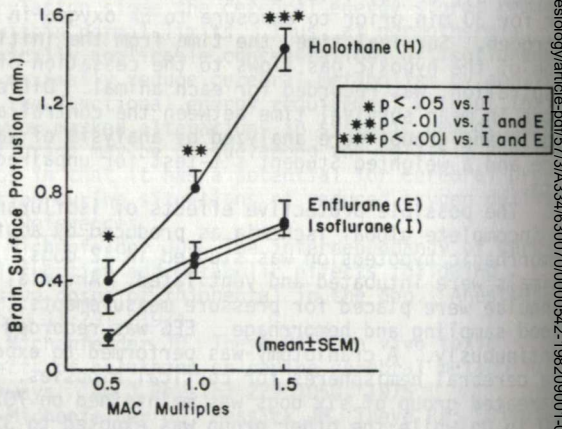

Fig.1: Brain surface protrusion during E, H and I anesthesia in cats at 0.5,1.0 and 1.5 MAC.

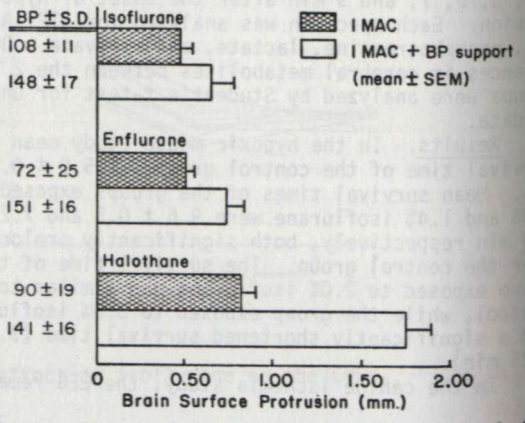

Fig.2: Brain surface protrusion during 1.0 MAC E, H and I anesthesia with and without BP support.