Increased Intracranial Pressure from Nitrous Oxide
Five Days after Pneumoencephalography

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Despite the development of less invasive tests, pneumoencephalography continues to find use as a diagnostic procedure in preoperative evaluation for intracranial surgical procedures. Residual air in cerebral ventricles following pneumoencephalography may present a hazard when nitrous oxide is inhaled, since diffusion of nitrous oxide into ventricles can markedly increase intracranial pressure. A delay before the use of nitrous oxide allows for absorption of the residual air and diminishes this hazard. A delay of two to three days has been recommended, but the following case suggests that this period may be insufficient.

REPORT OF A CASE

A 61-year-old woman had had acute right somatic weakness and ptosis of the left eye with diplopia eight days prior to operation. Neurologic examination showed left third cranial nerve palsy and right somatic hemiparesis with ataxia. Preoperative evaluation included pneumoencephalography five days prior to operation, computerized axial tomography (EMI scan), and cerebral angiography. A diagnosis of calcific suprasellar mass without signs of increased intracranial pressure was made. Treatment with dexamethasone and phenytoin was started one day before a temporal craniotomy was performed.

No premedication was given. Anesthetic induction and tracheal intubation were conducted so as to avoid increases in intracranial pressure. Incremental doses of thiopental (total, 500 mg) and a bolus of pancuronium, 5 mg, were administered iv. Nitrous oxide, 70 per cent in oxygen was administered with manually assisted hyperventilation, and the trachea was intubated after topical application of 4 ml lidocaine, 4 per cent. Hyperventilation was maintained (8.4 l/min) and low concentrations of halothane (maximum 0.5 per cent) were added to the anesthetic. Mannitol,

500 ml 20 per cent, was infused and dexamethasone, 10 mg, was given iv before the calvarium was opened. Arterial blood gases were $P_{O_2}$ 109 torr, $P_{CO_2}$ 20 torr, and $pH = 7.57$. Minute ventilation was decreased to 7.3 l/min with no change in arterial blood gases.

Upon opening the calvarium, the brain bulged excessively and it was assumed that ventricular fluid removal was necessary for brain decompression. As an Ender cannula was introduced into the ventricle, gas rather than fluid rapidly escaped. The bulging immediately disappeared, and the brain lay slack within the calvarium. The brain remained decompressed thereafter and the operation proceeded uneventfully. A review of preoperative radiographs showed that a large amount of the air used for pneumoencephalography five days before operation had still been present at angiography the day before operation (fig 1).

DISCUSSION

Saidman and Eger found that inhalation of nitrous oxide increased cerebrospinal fluid pressure following

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injection of air into cerebral ventricles in the dog, a finding recently confirmed by Stolkart in man. This effect results from the 36-fold greater solubility in blood of nitrous oxide compared with nitrogen. Nitrous oxide may be carried to the ventricles in volumes far greater than the volumes of nitrogen that may be carried away. For this reason, inhalation of nitrous oxide as anesthesia for pneumoencephalography or soon thereafter may be contraindicated when air is used as the contrast gas, particularly in patients who have pre-existing elevation of intracranial pressure, or decreased intracranial compliance. In patients without these conditions the risk may be minimal.

The data most commonly quoted by those who suggest a delay before nitrous oxide anesthesia come from Aird's study in 1937. Aird found that 90 per cent of air injected for pneumoencephalography was reabsorbed after two or three days. However, in some patients the air did not completely disappear for six or seven days.

Bergström et al. studied two groups of patients undergoing pneumoencephalography during general anesthesia with either halothane or methoxyflurane in nitrous oxide and oxygen. In one group nitrous oxide—oxygen was used for the contrast gas; in the second group, air was used as the contrast gas. The mean duration of retention of perceptible (by x-ray) volumes of nitrous oxide—oxygen contrast gas mixture in intracranial cavities was two days. When air was used as the contrast gas the mean was seven days. The quality of the pneumoencephalography was not compromised by using nitrous oxide—oxygen as the contrast medium.

It seems likely that in the case presented expansion by nitrous oxide of residual intraventricular gas accounted for the "bulging" of the brain observed at operation. This experience suggests that a two- or three-day period is insufficient for reabsorption of intraventricular air in all cases, and that a potentially hazardous increase in intracranial pressure happened to our patient as a result of the use of nitrous oxide for anesthesia. Therefore, when a patient has had an air contrast study within seven days of the proposed operation, two courses seem appropriate: 1) avoid the use of nitrous oxide in the anesthetic gas mixture, or 2) obtain preoperative x-rays to determine whether intracranial air is still present. Should air persist, the operation may be delayed to allow reabsorption, or it may proceed, avoiding nitrous oxide anesthesia.

References

Inadvertent Anesthetic Overdose Obscured by Scavenging

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Virtues of scavenging waste anesthetic gases have been extolled and failure to scavange condemned, although benefits of scavenging remain to be proven. It is generally assumed that elimination of waste gases is a sufficiently benign practice that no justifiable reason exists for failure to scavenge. This may be true, but it should be pointed out that the process of

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