to CSF formation but with time constants long enough to minimize the effects on our data. Perhaps the authors above are referring to a study by Aidinis et al.5 which was co-authored by one of them, where PEEP application resulted in CSFP changes with a shorter time course than we report. In that study6 where BP was not controlled, they did speculate that "the absolute increases in ICP (intracranial pressure) might have been higher and longer lasting if BP had not simultaneously decreased." In our study where BP changes were prevented, we found longer time constants as Aidinis et al.9 predicted.

The last issue to be addressed is the question of the influence of the level of stress on the resulting data. Our protocol, which was approved by the Animal Studies Committee, was designed to closely mimic the intensive care setting where head-injured patients are ventilated without sedation or anesthesia in order to evaluate mental status and neurological function. Our animals were given general anesthesia at least three days prior to the study for the implantation of the flow probes and catheters. On the day of the study the introduction of percutaneous catheters using local anesthetics was performed. The use of general anesthesia during the studies would not mimic the clinical setting and would further complicate the interpretation of the data because of the effects on CBF autoregulation. We have no evidence of stress based on heart rate, CO2 production (116.2 to 142.5 ml/min), or CBF (71 ml/min this study as compared to 75 ml/min10 and 47–68 ml/min in another study11). Thus, we do feel that our data are of value in understanding another aspect of the potential adverse effects of ventilation with PEEP.

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Dennis D. Doblar, Ph.D., M.D.
Resident in Anesthesiology
Walter Reed Army Medical Center
Washington, DC 20012

REFERENCES


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An Unusual Cause for Increased Resistance to Injection during Administration of Spinal Anesthesia

To the Editor.—An 83-year-old man with hypertension and an ischemic ulcer on his ankle was scheduled for split thickness skin graft under spinal anesthesia. He was hospitalized 18 years previously following a neck injury. At that time a myelogram using Pantopaque* and an anterior cervical fusion were performed.

The patient was placed in the lateral position and the subarachnoid space entered without difficulty using a 22-gauge, 8.9-cm Travenol† spinal needle. Cerebral spinal fluid flow was slow but continuous and contained an oily substance. One-tenth of a milliliter of CSF was withdrawn into a 6-ml Travenol disposable plastic syringe.

* LaFayette Pharmacal, LaFayette, Indiana 47904.
† Travenol Laboratories, Inc., Deerfield, Illinois 60015.
containing 1.0 ml of 1.0 per cent tetracaine and 1.0 ml of 10 per cent dextrose. The syringe was then disconnected from the spinal needle to allow close examination of the mixture, reconnected, and injection begun. After 1.0 ml of the mixture was injected, resistance to injection suddenly increased. Aspiration was accomplished easily so the injection was completed, but with significant resistance. The patient was turned supine and a level of T10 was achieved 15 min after injection. The intraoperative course was uneventful and recovery from the spinal anesthesia complete three hours after injection.

Pantopaque is the registered trademark for a mixture of isomers of ethyl iodophenylundecylate and when used as a contrast medium for myelography is never absorbed from the CSF. Pantopaque is deleterious to rubber articles and when it came in contact with the rubber tip on the syringe plunger, there was a change in the resistance of the syringe. This change may be reproduced easily with a small volume of Pantopaque using any syringe with a rubber tip on the plunger.

R. VICTOR GLICK, M.D.
Chief, Anesthesia Section Veterans Administration Medical & Regional Office Center
White River, Vermont 05001

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Prevention of Tension Pneumocephalus

To the Editor—We read with great interest the clinical report “Cardiac Arrest Associated with Tension Pneumocephalus,” by Thigrajah et al.1 Tension pneumocephalus is an infrequent but dreadful complication following craniotomy, especially performed in the sitting position. Their case certainly has emphasized this point. The report also has pointed out the importance of avoiding nitrous oxide one to two weeks following craniotomy, should surgical reexploration become necessary. However, we have a different explanation as to how the tension pneumocephalus has caused cardiac arrest and also different views on the prevention of this complication.

The authors have pointed out that in the sitting position, many reasons favor the air to accumulate in the subarachnoid space and become trapped in the frontal area. They also stated that “in this case, sudden cessation of cardiac action resulted from the obliteration of an escape site for gas.” Approximating the dural edges, in a practical sense, does not however cause “the obliteration of an escape site for gas.” Because the air is trapped and located above the surgical wound (posterior fossa craniotomy), one is unable to apply sufficient pressure to express the air downward and out via the incision; although that is theoretically possible (when the gas pressure is greater than atmospheric pressure and it is not trapped by a ball-valve mechanism). Instead, a more likely explanation is that the closure of the dural flaps does serve to increase the upward pressure on the substance of brain, making the intracranial container more rigid (less compliant), and to thereby increase the tension within the air pocket.

Nitrous oxide, we believe, in their case although discontinued five minutes before the dural flaps were approximated, aggravated the tension effect of the pneumocephalus and added force to the downward movement of the brain (herniation). Nitrous oxide alone does not cause cardiac arrest, but in this case it served as an indirect precipitating factor.

It is impossible to “flush the subdural space with saline to displace as much gas as possible” since the air pocket is located higher than the surgical wound, and also, it is not surgically feasible. Leaving the ventriculostomy drain open may relieve pressure, but in all likelihood does not serve as a gas escape route. Furthermore, a rubber tube drain at the upper and lower limit of dural incision used for flushing with saline does not displace the gas which is located higher up in the frontal area that is causing the downward movement of the brain. However, it may displace the air occupying the space left vacated by the tumor mass. The one way that would permit the air to escape with the patient in the sitting position is to place a twist drill hole on each side of the vertex.

We further advise that the intracranial pressure should be monitored through the ventriculostomy canula not just in the early recovery phase, but as soon as the dura is approximated to detect any increase in the pressure.

THOMAS TOUNG, M.D.
Associate Professor, Anesthesiology/ Critical Care Medicine

ROBERT T. DONHAM, M.D., Ph.D.
Associate Professor, Anesthesiology/ Critical Care Medicine
Director of Anesthesia Services

JAMES N. CAMPBELL, M.D.
Assistant Professor, Neurosurgery