Behavioral and 17-Hydroxycorticosteroid Changes Following Pneumoencephalography

S. R. Nelson, M. D., J. M. Montalvo, M. D., J. D. Smith, M. D., and O. J. Andy, M. D.

Departments of Neurosurgery and Pediatrics, The University of Mississippi Medical Center, Jackson, Mississippi

Responses to pneumoencephalography vary from mild to severe reactions which may include headache, nausea, vomiting and fainting. Some of the reactions are associated with an overwhelming involvement of the autonomic nervous system. Such responses are comparable to those reactions observed in patients submitted to other acute stressful states.¹⁰¹² Fly et al.³ found that the administration of steroids to patients having pneumoencephalograms reduced the severity and duration of headaches. Consequent to these observations, it was proposed that patients with severe reactions to pneumoencephalography may possess an inadequate endocrinologic response to factors of stress induced by the procedure. To evaluate this hypothesis, the levels of 17-hydroxycorticosteroids in serum were determined in patients undergoing pneumoencephalography. The levels of steroids were then correlated with the patient’s behavioral reactions which were ranked according to a “behavioral index.”

**Technique**

Twenty-six diagnostic procedures were done in 23 patients: 16 pneumoencephalograms, 4 arteriograms, and 6 lumbar punctures. The average age of the patients was 43 years, the range being from 16–62 years. Patients undergoing pneumoencephalography had the following disorders: 6 Parkinson’s disease, 3 seizures, 2 headaches, 2 sensory and motor disorders, and 1 memory deficit. Among patients undergoing arteriography 3 had headaches, and 1 had changes in personality. Patients undergoing lumbar punctures had the following disorders: 3 headaches, 1 seizures, and 1 low-back pain. Pre-medication in patients with pneumoencephalograms consisted of Nembutal and Demerol. No premedication was used in patients receiving lumbar punctures. Xylocaine (1 per cent) was employed for local anesthesia in all cases. Pneumoencephalography was performed on patients in the sitting position. With the exception of 1 patient who received 10 cc. of air, the rest received 30–60 cc. Arteriography was performed bilaterally in the common carotid arteries with the patient in the supine position. Each patient had 4–6 injections of 50 per cent Hypaque (10 cc. per injection). Lumbar punctures were performed on patients in the lateral decubitus position between 9:30–11:00 a.m., and pneumoencephalograms and arteriograms were done between 9:30 a.m.—3:00 p.m.

The levels of free 17-hydroxycorticosteroids in plasma were measured. A control sample was taken 15 min. prior to the initiation of each study. Remaining samples were taken at ½ hr., 3 hrs., 6 hrs., and 24 hrs. after the onset of the study. The concentrations of steroids were determined by a modification of the phenylhydrazine sulfuric-acid technique of the Porter-Lilber method. Behavioral changes were divided into 4 categories: (1) vital signs, (2) subjective and objective changes, (3) medication and (4) intake of food. The first two of these categories were evaluated in blocks of 6 hrs. over a 24-hr. period. The 3rd and 4th categories were each considered for the total 24-hr. period. Four behavioral units were allowed in each category in a 24-hr. period; thus a total of 16 behavioral units was possible in each patient. Significant changes in vital signs consisted of a minimum systolic rise in blood pressure of 10 mm. Hg, a 10/min. change in pulse rate, and a 1°F. change in temperature. Patients were given 0.32 behavioral index units for each 6-hr. period in which a significant change in vital signs occurred. Subjective complaints such as headache, nausea, vomiting and chills were also considered in blocks of 6 hrs. over a 24-hr. period. If any of these were present during a 24-hr. period 1 unit was given to each 6-hr. block in which it occurred. Medication was given a value in terms of 1 unit per each dose of narcotic, analgesic, or sedative. A maximum of 4 units was possible in this category, even if a patient received more than 4 doses in a 24-hr. period. The

Received for publication March 4, 1964.

* Presented at the 17th annual meeting of the Neurosurgical Society of America, Phoenix, Arizona, January 22–26, 1964.

Supported in part by N.I.H. Grants §3 T1 NB 5411 and §AM 04892.
category of diet was evaluated by ascribing 1.3 units to each meal refused during a 24-hr. period. This was based on the patients being served 3 meals in 24 hrs.

Analysis of Rank of Behavior. The patients were ranked according to their behavioral index (Table 1).

**Results**

Steroid and Behavioral Responses Following Pneumoencephalography. Responses of 17-hydroxycorticosteroid in plasma reached a mean peak value of 15.5 μg per 100 ml. above the control level within ½–1 hr. after injection of air. Following the peak there was a gradual fall over a 24-hr. period (Fig. 1). At the end of 24 hrs. the mean value was 14.2 μg per 100 ml., a difference of only 1 μg. from the mean control level before pneumoencephalography, which was 13.3 μg. There was no appreciable difference in the response curve between pneumoencephalograms performed in the morning and those performed in the afternoon.1

The behavioral index was highest in the patients with pneumoencephalograms. The ranges were 0.32–2.00 for lumbar puncture, 1.64–3.64 for arteriogram and 1.32–13.00 for pneumoencephalogram. It was noted that patients with a triad of headache, nausea and vomiting had an average higher level of steroids within 1 hr. than those with headache alone (Fig. 2). Patients with Parkinson's syndrome as a group had lower behavioral reactions and relatively higher steroid responses following pneumoencephalography. Patients with non-Parkinson's syndrome displayed a greater magnitude of behavioral reactions with a wider variability in steroid responses (Fig. 3).

Arteriogram and Lumbar Puncture. The steroid responses following arteriography were closer to those of pneumoencephalography than lumbar puncture (Fig. 4). The

![Fig. 1. Steroid levels taken at intervals over a 24-hr. period following diagnostic studies. Circles = pneumoencephalograms; squares = arteriograms; and triangles = lumbar punctures. The left end of the interrupted graph represents the pre-diagnostic control levels (C). Mean values are represented for the patients within each of the 9 groups.](image-url)