AIR EMBOLISM OCCURRING DURING ENCEPHALOGRAPHY

REPORT OF TWO CASES

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The effects of free gas in the blood stream have been known for some time. While experimenting with injection of air into the venous system of animals Legallois, in 1829, recognized that sudden death could be produced and even suggested that some of the deaths occurring postpartum in women might be due to air emboli. It was not until 1850 that Cormack reported such a case.

Since then, numerous reports and studies have appeared describing various conditions under which free air or gas may get into the vascular tree. Besides those connected with pregnancy, air may be aspirated into veins during neck and mediastinal operations, during operation performed in the sitting position, and following the diagnostic injections of air. Accidental deaths have occurred following injection of air into the pleura, around the adrenals, and into the peritoneum, the bladder and the vagina.

As far as the authors can determine, however, air emboli have not been reported following the injection of air into the subarachnoid space for the purpose of producing encephalograms. Davidoff and Dyke, in their monograph on the encephalogram, do not mention this complication, nor does Dandy in his various papers. Since the procedure is used so commonly the accident must have occurred in the past, but was either not recognized or not reported.

Since the condition is so rarely encountered, it is felt that the following unfortunate cases should be reported in detail.

REPORT OF CASES

Case 1. History #421566. A 54-year-old white male entered the hospital with the complaint of tiredness and loss of weight. The family and past histories were non-contributory.

The present illness began in December, 1946, with a feeling of weakness and fatigue. He felt as though he had lost his "grip" on his daily duties. He had had similar attacks in the past which were characterized by fatigue, depression and inability to concentrate. His position as a railroad telegraph operator was described as "nerve-racking." In the past he had remained at home and rested for several months after these attacks.

In January, 1947, his brother was killed in a railroad accident. This aggravated the symptoms of "nervousness" and fatigue. Finally on April 29, 1947, he quit work. While at home, alone, the following day, he experienced a severe attack of cardiac palpitation, following which he fainted. A friend found him unconscious and took him to a local hospital. He recovered promptly but during the next few days there were several mild headaches and he vomited twice without apparent cause. Routine studies failed to account for the symptoms and the patient was transferred to this hospital as a brain tumor suspect.

Physical examination disclosed a well developed and well nourished white man who was a little slow mentally. The cardiac system appeared normal. The blood pressure was 120/70. The left leg had been amputated below the knee 34 years before and the stump was not remarkable. The neurological and ophthalmological examinations were entirely normal. X-rays of the skull and chest failed to disclose any abnormalities. Routine laboratory studies of the blood and urine were not remarkable. The serologic test for syphilis was negative.

On the following day an encephalogram was attempted under pentothal anesthesia. With the patient in the horizontal position, a lumbar puncture was done at the 4th lumbar interspace. The pressure of the cerebrospinal fluid was 130 mm. The Queckenstedt test failed to disclose any block. A second needle was then inserted into the 3rd lumbar interspace and the
patient was elevated, on his side, to about 45° above the horizontal. Using the "two-needle" technique, 140 cc. of fluid were removed and a similar amount of air was injected. The air was not injected under any significant pressure.

While the cerebrospinal fluid was being evacuated, the patient suddenly became cyanotic and within a few seconds stopped breathing. The injection was stopped as soon as an untoward change in the patient's condition took place. An intratracheal tube was inserted immediately and artificial respiration was applied. The heart sounds were very distant. Despite intracardiac stimulation and artificial respiration, the patient died in a few minutes. X-rays of the head taken a few minutes after death showed a normal ventricular system.

Postmortem examination done about 12 hours after death revealed air in the veins in all parts of the body. Air escaped from the vessels of the chest and abdominal walls when the initial postmortem incisions were made. The heart was dilated, especially the right auricle and ventricle. As it was opened, air escaped under pressure. There was bloody froth in all the chambers. Air could be seen in the mesenteric vessels and in the subarachnoid space. The arteries were sclerotic throughout the body. Detailed examination of the brain failed to demonstrate any lesions. No gas-forming organisms were cultured in the routine postmortem bacteriological studies.

Case 2. History #438864. Child aged 6 months. Family and past histories non-contributory. The present illness began 12 days after birth when the child had spontaneous periods of cyanosis and rigidity. Following them the baby was lethargic and would sleep for several hours. At the age of 3 weeks, it was felt that the thymus was enlarged. Some x-ray treatments were given to that region.

The "spasms" became more frequent and the child had up to 20 a day. About Aug. 20, 1947, phenobarbital, 0.5 gr., was prescribed. This was not given regularly. Shortly after this the character of the spells changed. The child now had sudden episodes of rigidity which followed a short cry. The eyes would roll up into the head. There were tonic movements. Later the dosage of phenobarbital was raised to 1 gr. 3 times a day. Even under this régime the child had 3 to 4 attacks a week.

Physical examination showed a well developed and well nourished child. The anterior fontanelle was open, measuring 4 x 6 cm. It was soft and flat. The head measured 44 cm. in its greatest circumference. The arms and legs seemed shorter than normal. No abnormal neurological findings were demonstrated.

X-rays of the skull did not show any abnormalities. X-ray studies of the long bones did show changes typical of achondroplasia. Blood studies and many blood chemical determinations were within normal limits.

On Oct. 18, 1947 a lumbar encephalogram was done; 50 cc. of fluid were withdrawn in increments of 10 cc. A like amount of air was injected. The fluid was blood-tinged at the end of the procedure. While preparations were being made to take the x-rays, the child suddenly stopped breathing. The heart beat stopped simultaneously. Despite artificial respiration and intracardiac drugs, the child could not be revived.

At autopsy, 6 hours after death, the heart was opened under water. It was filled with frothy fluid. When the right auricle was opened, there was an escape of free gas. There were no other findings of significance. The site where air entered the venous system was not found.

DISCUSSION

These 2 cases are placed on record because during a 30-year period of encephalography in the Johns Hopkins Hospital, no similar complications have occurred. Both injections were made by house-officers with more than average experience on the Neuro-Surgical Service and it is therefore known that neither an excess of air, nor an excess of pressure was used during the procedure.

The site at which the air entered the vascular tree could not be determined post mortem in either case. Since no blood flowed out of either of the lumbar puncture needles when they were inserted, it seems very unlikely that it entered any of the epidural veins in the lumbar
AN IMPROVED TREPHINE

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In this paper an improved skull trephine designed by the author is described. It has been used since April 1947 by the neurosurgical department of the Lahey Clinic in a sufficient number of cases to prove its worth. This instrument was developed after repeated urging by Dr. James L. Poppen and was the outgrowth of difficulties encountered with the older type of trephine, namely, easily dulled and slow-cutting teeth, and the necessity for drilling a starting hole for the center point of the trephine. These difficulties have been completely eliminated by the new design, and a bone button can be removed rapidly from any type of skull with a minimum of effort, owing to the size and set of the cutting teeth. The original model has been in use at the clinic for 115 lobotomies and 230 bone buttons consecutively, and the cutting blade has neither been resharpened nor replaced. The instrument was built primarily for use in prefrontal lobotomies; however, the same type but of smaller caliber can be used for biopsies or craniotomies (frontal). The adaptation of trephines attached to the Hudson brace is not original with us. The design of the trephine, however, is new.

The instrument consists of 4 main parts: the shank, the guard, a cutting blade, 1 inch in diameter, and center drill. The cutting blade and center drill are made of high speed tool steel, which accounts for the excellent durability, and the remainder of the instrument is made of stainless steel, to avoid rusting and chrome-plate flaking. The original model consisted of a shank and guard of brass with the steel cutter, but owing to the softness of brass, it was thought that stainless steel was far superior. The trephine is shown in Fig. 1. The cutting blade is held onto the shank by a stainless steel nut and the center drill slides into the shank until it rests against the bottom of the hole, and is held by a headless set screw. The guard slides down over the cutting blade until about 1 cm. of blade is exposed, and is locked in position with another headless set screw. A 1 cm. depth setting, in our experience, is correct for at least 80 per cent of all skulls trephined in the prefrontal region. When a thick skull is encountered, the guard is loosened and set back slightly to allow a deeper cut, whereas if the skull is thinner than usual, the trephine may drop through against the dura, but only for a few mm., and will not cut the dura if the instrument is turned slowly as recommended. Fig. 2 shows the instrument disassembled.

The trephining is done dry, without use of water or saline solution, and the Hudson brace is turned slowly, using firm pressure against the skull. It is not necessary to drill a starting hole since the center drill rapidly cuts its own hole. When the teeth have cut into the bone to a depth of about 2 mm., the center drill is removed, and the remainder of the bone is cut.

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REFERENCES