Current Comment

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Anesthesia by Remote Control During Radiation Therapy

Treatment of cancer by roentgen-ray has been used for many years. More recently, various radioactive techniques have been employed in an attempt to increase the effectiveness of cancer therapy. In the fall of 1960 the Neurosurgical Service at the Massachusetts General Hospital, Boston, presented Drs. E. M. Slater, A. D. Surtees, J. A. Tassie and D. P. Todd of the Anesthesia Department with the problem of giving anesthesia during radiation treatment of intracranial tumors.

Approximately two weeks after an initial craniotomy and extirpation of tumor, a patient was to be brought to the medical treatment room of the reactor at the Massachusetts Institute of Technology. Under general anesthesia a second craniotomy was to be performed, a boron solution given intravenously, and the area of tumor exposed to neutron bombardment for 45 to 105 minutes.

Surgical anesthesia was required throughout craniotomy and the subsequent exposure to as much as 30,000 roentgens. During this period the patient was to remain in the room unattended. As shown in figure 1, he was to be separated from the surgical and anesthetic team by lead lined walls 4 feet 6 inches in thickness and an overall distance of about 20 feet. A small consolation, at least, was that the patient could be observed at this distance through an oil-filled window in the wall. During the neutron therapy the patient (and op-

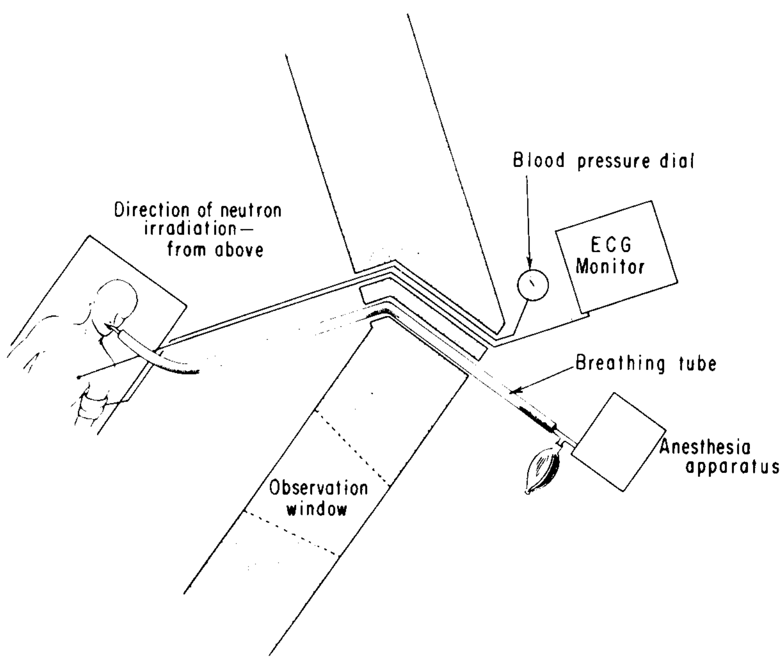

FIG. 1. Schematic diagram of the reactor.

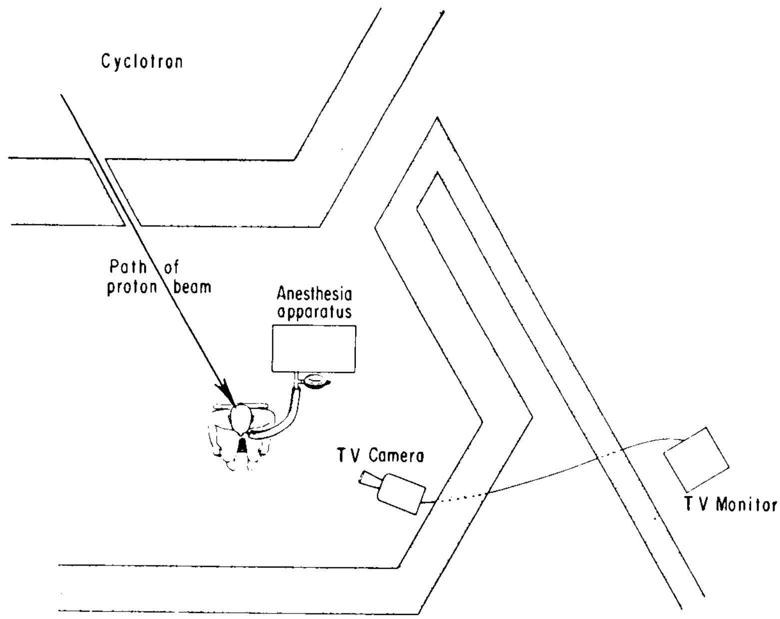

FIG. 2. Schematic diagram of the cyclotron.

erating table) were to be elevated to the ceiling where the portal from the reactor was located, a height of approximately nine feet. Finally, the anesthetic technique had to be nonexplosive.

It was decided that the simplest means of maintaining adequate control of the patient under these circumstances was to have him breathe spontaneously through a Ruben nonrebreathing valve connected by a 30 foot length of wide-bore (2 inch) non-kinkable tubing to an anesthesia machine outside the room. The tubing could be led through a Z-shaped tunnel in the wall of the room.

The following method has been used in 16 cases without any anesthetic complications. A blood pressure cuff was applied in the usual manner, and an intravenous infusion of 5 per cent dextrose in water started via a percutaneous intravenous catheter.* Following induction of anesthesia with thiopental-succinylcholine, the patient's trachea was intubated and halothane-nitrous oxide and oxygen were administered via the open system of a Boyle anesthesia machine. (During the initial surgery the machine can remain in the operating room connected to the valve by a length of regular corrugated tubing.)

The wide-bore breathing tube, 20 feet of rubber connections for a stethoscope and blood pressure cuff, and the electrocardiograph leads were left permanently in place in the wall tunnel. Prior to the neutron bombardment, all tubing and leads were connected to their extensions. It was surprising how satisfactorily blood pressure can be determined through this long length of tubing. The electrocardiograph leads were connected to an electrocardiograph recorder-oscilloscope with audible signal. Blood pressure, pulse rate and pulse rhythm were accurately monitored with this system.

While the above adjustments were being made by one anesthetist, the machine and another anesthetist were in the operating room with the patient. When the craniotomy was completed and after the boron had been administered, the machine was moved from the room to a point outside the window. The 30 foot breathing tube was attached to the Ruben valve at one end, and to the anesthesia machine at the other. After all apparatus was placed and checked, all doors were closed, the radiation portal was opened and neutron bombardment began.

* When the patient is placed in position above the intravenous solution, the catheter remains patent if flushed and clamped.

At a 4-liter flow of nitrous oxide and a 4-liter flow of oxygen with 0.5 to 1 per cent halothane, spontaneous respirations were easily maintained for the necessary period of time. Assisted or controlled ventilation was readily accomplished when necessary. Respiratory rate and depth were easily observed.

Reactor Patients

Patient	Age (in years)	Sex	Diagnosis	Time (in minutes) of Neutron Bombardment	Anesthetic Complications
1	51	F	Glioblastoma multiforme	65	None
2	55	F	Glioblastoma multiforme	90	None
3	59	F	Glioblastoma multiforme	75	None
4	47	F	Glioblastoma multiforme	105	None
5	57	M	Glioblastoma multiforme	60	None
6	48	F	Glioblastoma multiforme	60	None
7	36	M	Glioblastoma multiforme	45	None
8	39	F	Glioblastoma multiforme	45	None
9	14	M	Cerebellar astrocytoma	45	None
10	43	M	Glioblastoma multiforme	45	None
11	20	F	Glioblastoma multiforme	45	None
12	29	F	Glioblastoma multiforme	60	None
13	24	F	Glioblastoma multiforme	30	None
14	63	M	Glioblastoma multiforme	60	None
15	14	F	Cerebellar medulloblastoma	90	None
16	43	M	Glioblastoma multiforme	75	None

Cyclotron Patients

Patient	Age	Sex	Diagnosis	Total Dose (in rad.)	Number of Separate Treatments	Anesthetic Complications
1	3	F	Glioma of hypothalamus	9,500	3	None
2	7	F	Cortical glioblastoma	8,000	2	None
3	12	M	Carcinoma of pituitary gland	16,000	4	None
4	12	M	Pontine glioblastoma	3,970	1	None

If an emergency should arise during the radiation period, the reactor portal can be closed instantaneously, and the ventilated room safely entered in less than 30 seconds.

In June of 1961 the same group of neurosurgeons began to study the effect of proton bombardment on radiosensitive brain tumors at the Harvard University Cyclotron Laboratory. Up to July 1962, four children have received this type of treatment under general anesthesia. Anesthesia was required in this situation only to prevent movement. A craniotomy was not performed and, therefore, adults could be treated readily without being anesthetized.

There are two main differences between the reactor and the cyclotron in relation to the administration of anesthesia. At the cyclotron closed circuit television is used to observe the patient (fig. 2). Second, instead of one prolonged bombardment, exposure was divided into 5 to 10 three-minute periods. Therefore, the machine was left in the room with the patient throughout the treatment.

The following technique has proved satisfactory at the cyclotron. The patient was induced with halothane and oxygen via a Ruben nonrebreathing valve attached to the open system of a Boyle anesthetic machine. The patient's trachea was intubated with a Tovell tube of appropriate size, which was then connected to the Ruben valve. After the patient was positioned and vital signs checked, the patient and the machine were left unattended. Respiratory excursions and gas flows were watched constantly by a television camera. Pulse and blood pressure were not, in this instance, monitored during the bombardment period.† After each three minute interval, the anesthetists returned to the room to check vital signs while the patient was repositioned for the next treatment.

The television camera showed a picture which was clear enough to read the flowmeters easily. Obstructed breathing or apnea could be observed quickly by focusing on the rib cage or breathing bag. In case of difficulty, the beam could be interrupted and the room entered without delay.

† The authors expect to be able to do so in about six months.