Extracorporeal Oxygenation for Induction of Anesthesia in a Patient with an Intrathoracic Tumor

KENNETH D. HALL, M.D.,* AND MARILYN FRIEDMAN, C.R.N.A.†

We have successfully used extracorporeal oxygenation for induction of anesthesia in a patient with an intrathoracic tumor.

REPORT OF A CASE

A 14-year-old girl was admitted to the hospital with the chief complaint of swelling in the neck upon straining. Specifically, her mother noticed a bulging at the suprasternal notch whenever the child performed a Valsalva maneuver. Upon close questioning, she also reported occasional shortness of breath with heavy exercise. No history of tachypnea could be elicited. Results of physical examination and laboratory findings were entirely normal except that the roentgenogram of the chest showed a mass in the anterior mediastinum (fig. 1).

On two occasions a general anesthetic was administered for exploration of the anterior mediastinum. On the first occasion, shortly after induction of anesthesia with thiopental, halothane, nitrous oxide, and succinylcholine, 20 mg. to facilitate tracheal intubation, the child, who by then was receiving pure oxygen, became deeply cyanotic. Absence of breath sounds in the left anterior chest was noted. The position of the endotracheal tube was checked to exclude the possibility of endobronchial intubation. Because of continued cyanosis, the anesthetic was discontinued, whereupon the patient’s color returned to normal and breath sounds reappeared in the left chest. On the second occasion, two days later, anesthesia was induced with nitrous oxide and halothane but with no muscle relaxant. It was assumed that the position of the mass, and its encroachment upon the left main bronchus, would be disturbed less by spontaneous respirations than by intermittent positive-pressure breathing. Within a minute or two, however, the child became cyanotic again, retched and strained, and became more deeply cyanotic. Anesthesia was immediately discontinued. As she was awakening, the surgeon inserted a needle into the anterior mediastinum just to the left of the sternum between the second and third ribs, and withdrew 30 ml of straw-colored fluid. The child’s color and breath sounds returned to normal.

It was deduced from these events that the tumor probably compressed the pulmonary arteries rather than the bronchi, and that it was probably not malignant. The former hypothesis was verified by angiographic fluoroscopy and the latter by cytologic studies of the straw-colored fluid. It was decided, therefore, to utilize extracorporeal circulation to maintain oxygenation during induction of anesthesia and until the chest could be opened and the pressure of the tumor mass on the pulmonary arteries relieved.

The entire procedure was explained in detail to the child and parents. The child weighed 50 kg and was given seconal, 100 mg, intramuscularly for premedication. Anesthesia was begun with Innovar, .5 ml, administered intravenously. Five minutes later an additional .5 ml of Innovar was given. A radial-artery cannula was inserted, and a blood-gas sample drawn with the patient breathing room air had a Pao₂ of 32 torr. Delivery of pure oxygen by mask was begun immediately, and Pao₂ increased to 78 torr. Using local anesthesia, a cutdown was performed in the right groin, and after heparinization, cannulas were inserted into the right femoral artery and vein and attached to a cardiopulmonary bypass unit that had previously been primed with whole blood and saline solution.

Extracorporeal oxygenation was begun, with Pao₂ stable above 300 torr, and anesthesia was induced with thiopental, 250 mg, halothane, 0.5 to 1 percent, and pancuronium bromide, 6 mg. Nasotracheal intubation was performed and mechanical ventilation established. The EEG was monitored.

* Professor of Anesthesiology.
† Staff Nurse Anesthetist.

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† Droperidol, 2.5 mg. fentanyl 0.05 mg.
continuously. Cardiovascular function remained stable and $P_{a_{O}}$ remained above 300 torr. The chest was opened through a left anterolateral thoracotomy which was later extended to an upper median sternotomy. Attempts were made to discontinue extracorporeal oxygenation, but when the surgeon pressed on the mass, $P_{a_{O}}$ decreased rapidly from 300 to 20 torr. For this reason it was necessary to maintain cardiopulmonary bypass most of the time at 2,000 ml/min (three fourths of the estimated cardiac output) until the chest was widely opened and the tumor had been partly resected. The remainder of the resection was done without the extracorporeal unit. The child was awake at the conclusion of the operation and she made an uneventful recovery. The tumor was diagnosed as a dermoid cyst.

**FIG. 2.** Continuous recording of arterial blood pressure, central venous pressure, and EEG during a period of compression of the pulmonary artery. Surgeon's hand on tumor compressed pulmonary artery (top left). Arterial blood pressure decreased in 5 seconds, then 5 seconds later returned to normal spontaneously as compression was partially relieved. Remaining partial compression led to marked EEG change 5 seconds later. Blood sample drawn when indicated: $P_{a_{O}}$, 18 torr, pH 7.24, $P_{a_{CO}}$, 67 torr. Cardiopulmonary bypass was instituted immediately as the sample was being drawn and by 9:06 the EEG had returned to normal. Twenty-four minutes later, with no change in the ventilator setting: $P_{a_{O}}$, 525 torr, pH 7.54, $P_{a_{CO}}$, 25 torr.

**DISCUSSION**

The most striking thing about this case was the fact that no hypoxia was evident in the awake state, but profound hypoxia ensued during anesthesia. Severe depression of $P_{a_{O}}$ occurred after only 1 ml of Innovar. Whether hypoxia occurred during normal sleep is not known. Presumably normal thoracic muscular tone and intrathoracic pressure fluctuations during awake spontaneous breathing somehow maintained pulmonary arteries patent, but with anesthesia, muscular tone was decreased and intrathoracic pressure patterns changed so as to allow the tumor mass to fall...
posteriorly and occlude the pulmonary arteries. Since the slightest compression of the mass in various directions by the surgeon's hand during the initial resection resulted in severe hypoxia, it may be concluded that positioning the patient in the lateral or sitting position would not have significantly relieved the problem or rendered extracorporeal oxygenation unnecessary. The only position that might possibly have been beneficial would have been the prone position, allowing the mass to fall anteriorly, but the resection would have been technically difficult, if not impossible, with the patient in this position. Partial aspiration of the cyst did not relieve the hypoxia, and since during resection of the tumor it was noted that the cyst did not constitute a significant portion of the tumor mass, it may reasonably be assumed that complete aspiration of the cyst also would not have significantly relieved the compression of the pulmonary artery or have obviated the need for external oxygenation.

The EEG was an essential part of the monitoring in this patient. Sudden and severe hypoxia was immediately diagnosed from analysis of the EEG and was confirmed by simultaneous blood-gas sampling showing low PaO₂ values (fig. 2). This monitoring allowed immediate adjustment of surgical compression or cardiopulmonary bypass flow rates. For example, it was determined that when the surgeon's hands were severely compressing the pulmonary arteries, as was unavoidable during parts of the resection, the flow rate had to be maintained at 2,000 ml/min for adequate oxygenation, whereas at other moments a flow rate of only 500 ml/min was adequate. When enough of the tumor had been removed that oxygenation was achieved with zero flow rates, cardiopulmonary bypass was discontinued. It is our belief that this child could not have survived the induction of anesthesia and the early part of the surgical dissection if extracorporeal oxygenation had not been used.

In summary, a 14-year-old girl had a dermoid cyst removed from her anterior mediastinum with arterial oxygenation maintained by cardiopulmonary bypass to counteract severe compression of the pulmonary artery by the tumor during anesthesia.

Use of Enflurane for Pheochromocytoma Removal

FERNANDO T. ORTIZ, M.D.,* AND PEDRO M. DIAZ, M.D.†

The surgical mortality associated with pheochromocytoma has been markedly reduced in recent years because of improvements in medical, surgical and anesthesiologic management.

Crout and Brown† described a rational approach for the anesthetic management of pheochromocytoma. Pretreatment with phenoxybenzamine (Dibenzylzine) an alpha-adrenergic receptor blocker, controls blood pressure and expands plasma volume. Beta-adrenergic receptor blockers are used only if needed to control sinus tachycardia or ventricular arrhythmias. The use of methoxyflurane as the anesthetic agent prevents ventricular arrhythmias. However, since methoxyflurane is nephrotoxic, the search for a better anesthetic agent for these patients continues.

The following is a report of a pheochromocytoma in which the regimen described by Crout and Brown was followed, with enflurane (Ethane) used as the anesthetic agent.

REPORT OF A CASE

A 28-year-old Caucasian man was admitted to the hospital with a six-month history of intermittent episodes of headache, nervousness, sweating, palpitations, and diarrhea. The physical examination was essentially negative except for a pulse rate of 110/min and a blood pressure of 160/100 torr.