A CONSIDERATION OF ANESTHESIA DURING CARINAL RESECTION * †

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NEW surgical procedures, especially in the field of thoracic surgery, frequently evoke complex problems for the anesthesiologist. Intrapleural operations introduced difficulties which, with the use of closed endotracheal and endobronchial technics, became far less formidable. Recently more radical operations have been performed in which pneumonectomy is accompanied by resection of the carina, trachea, or contralateral main stem bronchus. These radical operations introduced several interesting problems from a theoretical and practical viewpoint.

As in any anesthetic procedure, adequate oxygenation must be provided by delivering oxygen, by making certain that the lungs function at optimal capacity and efficiency, and by supporting the circulatory system to assure adequate transport of oxygen.

In the presence of an open pneumothorax the chief factors which interfere with normal functioning of the respiratory and circulatory systems are mediastinal flutter, mediastinal shift, decreased expansion of the lungs and neurogenic reflex cardiocirculatory depression. These disturbances to respiration and circulation are ordinarily circumvented by the proper use of compensated or controlled respiration (1,2), facilitated by the employment of a closed endobronchial or endotracheal technique.

Preliminary discussion with Dr. Sarot, the thoracic surgeon, led to the conclusion that these technics are not applicable to this type of surgery. When the trachea is being resected the surgeon requires (3) unobstructed visualization to determine the extent of the lesion to be resected. Again, when the defect is being repaired the presence of an endobronchial tube obscures the potential hazard of kinking or undue narrowing of the lumen of the trachea, which does not become evident until the tube is removed. An endobronchial tube *in situ* would interfere with these observations.

When the tracheal wall or bronchus is resected an opening is created which is of greater diameter than the trachea itself. This

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results in preferential exchange of air between the lung and the open chest rather than between the lung and the trachea above the defect. Thus an endotracheal tube which ends above the defect is of limited value.

To avoid the possibility of mediastinal shift or flutter, the mediastinum is supported during this period by traction sutures placed in the wall of the contralateral main stem bronchus and the adjacent tracheal wall. Abbott (4) stated, "It is felt that this stabilization allows the intrapleural pressure in the . . . (closed) hemithorax to become adequately negative in relation to atmospheric pressure to allow adequate aeration of the . . . (good) lung." The maintenance of the mediastinum in a position close to its normal midline site increases the expansion and efficiency of the remaining lung. As long as the remaining lung can expand sufficiently to maintain the tidal air at its normal value, especially if the inspired air is enriched by oxygen, adequate body oxygenation can be maintained (5). Donaldson (6) postulated that the kinking or torsion of the great vessels as the heart is shifted out of its normal position interferes with the circulation. Burstein and Alexander (1) presented additional evidence of detrimental reflex cardiocirculatory depression caused by mediastinal activity especially when the heart has been rotated or dislocated. These deleterious effects, too, are avoided by the use of traction sutures.

Another danger resulting from an open bronchial or tracheal stump is the possibility of drowning or asphyxia from obstruction caused by secretions, blood or loose tissue. The importance of keeping the tracheobronchial tree of the one remaining functioning lung absolutely clean cannot be overemphasized.

Anesthesia was induced and maintained as for straightforward open chest cases using cyclopropane and ether delivered through a cuffed endotracheal tube until the trachea was opened. At that time the major problem, from the anesthesiologist's point of view, was the avoidance of hypoxia. As will be shown in our first case, for a relatively short period continuity between the trachea above and the lung below was lost. During this time evidence of progressive hypoxia became manifest. It was to avoid this that the innovation in technic was required. As soon as the trachea was opened the surgeon passed the proximal end of a sterile number 14 French catheter up through the endotracheal tube under vision and the distal end down into the bronchus of the functioning lung. Large volumes of oxygen and anesthetic mixture were supplied through this catheter. At this time, also, a slow intravenous infusion of pentothal was started to supplement the inhalation anesthesia as necessary. After the tracheobronchial anastomosis was completed and airtight system re-established, the endobronchial catheter was removed through the endotracheal tube. Anesthesia was then continued as before.

Case 1.—A man, 65 years of age, came for examination because of recent weight loss and hemoptysis. A diagnosis was made of carcinoma of the right upper lobe. Operation was performed September 29, 1950.

Demerol, 75 mg., and atropine sufate, 0.4 mg., were given one hour before anesthesia, which was induced with cyclopropane and ether. Orotracheal intubation was carried out with a number 36 anode tube; the cuff inflated immediately. Anesthesia was continued with ether and cyclopropane. The patient was placed in the prone (Overholt) position. The pleura was opened fifteen minutes after beginning the operation. Respiratory exchange was maintained by compensated respiration. The traction sutures were placed in the medial wall of the left main bronchus and left lateral wall of the trachea. The surgeon stated that the trachea was about to be incised. A slow intravenous drip of 0.4 per cent pentothal was begun and large volumes (6 to 7 liters per minute) of oxygen were insufflated through the endotracheal tube. Within three minutes the systolic blood pressure began to rise, with a resultant increase in the pulse pressure. The pulse became slightly irregular, and dropped beats and coupled rhythm were noted. Procaine amide, 200 mg., was given intravenously. This immediately corrected the arrythmia. Eight minutes later the surgeon announced that the resection and anastomosis in the region of the carina had been completed. The remaining lung was inflated and the system found to be airtight. Compensated respirations were resumed and the blood pressure returned to its original level. The remainder of the operation was completed uneventfully. The postoperative course was uncomplicated.

Case 2.—A man, 58 years of age, came for examination because of hemoptysis. A diagnosis was made of carcinoma of the right upper lobe. Operation was performed December 22, 1950.

Premedication consisted of morphine sulfate, 8 mg., and scopolamine hydrobromide, 0.4 mg., one and one-half hours before anesthesia, which was induced with cyclopropane and ether. Orotracheal intubation was performed with a number 32 Magill tube; the cuff inflated immediately. Anethesia was continued with ether. The patient was placed in the prone (Overholt) position. The pleura was opened twelve minutes after the beginning of the surgical procedure. Respiratory exchange was assisted by compensated respiration. Traction sutures were placed in the medial wall of the left main bronchus and the right lateral wall of the trachea. The surgeon announced he was about to incise the trachea. After resection of the carina, adjacent trachea and left main bronchial wall the surgeon passed a sterile number 14 French catheter, the proximal end through the lumen of the visible cuffed endotracheal tube toward the anesthetist and the distal end into the left main stem bronchus. The open trachea was temporarily closed by manual traction on the crossed traction sutures. An intravenous drip of 0.4 per cent pentothal had been begun when the trachea was first incised and a flow of 3 liters per minute of nitrous oxide and 2 liters per minute of oxygen was insufflated through the catheter directly into the left main bronchus. The blood in the wound became slightly darker and the color of the skin of the face and ears became dusky. The flow of oxygen was increased to 5 liters and nitrous oxide decreased to 1 liter. Almost immediately the color of the blood in the wound and the hue of the skin improved. The systolic blood pressure which had risen abruptly declined toward its original level. The pulse rate, however, increased markedly. The pneumonectomy was completed rapidly. The pathologist examined the lung grossly at the table

and reported that the resection had been performed too close to the proximal end of the tumor. The traction sutures were uncrossed and another ½ inch (1.5 cm.) of the left medial wall of the main bronchus was resected apparently through normal tissue. The anastomosis was then completed. The surgeon was able to perform his work with no interference from the catheter and completed the resection and anastomosis in twenty-four minutes. The left main stem bronchus was then well suctioned through the catheter by the anesthetist, after which the catheter was withdrawn through the endotracheal tube. The left lung was inflated, and the system found to be airtight. Compensated respirations were resumed and the remainder of the operation completed. The postoperative course was uneventful.

COMMENT

Up to the present time, in both cases which were managed by this technic breathing was spontaneous when the trachea was opened. This is greatly to be desired. The possibility, however, of the patient being apneic must be considered. Gillespie (7) discussed many methods of resuscitation by insufflation technics by which oxygenation can be maintained even in the absence of respiratory movements. Beginning with Meltzer and Auer (8) the insufflation of anesthetic mixtures intratracheally became an accepted practice. As long as the catheter is of a small enough diameter to permit excess gas to escape this is a relatively safe procedure. It has been demonstrated that adequate oxygenation can be maintained; however, a slow but progressive retention of carbon dioxide occurs. This is not considered to reach clinically significant levels in less than thirty to forty-five minutes. Draper, Whitehead, et al. (9, 10, 11, 12, 13, 14) have demonstrated that by the action of the "hemoglobin-oxygen pump" in the presence of respiratory arrest, when circulation is adequate and the nitrogen of the respiratory tract has been largely replaced by oxygen, sufficient diffusion occurs to maintain arterial oxygen content at normal levels for thirty minutes. The arterial carbon dioxide content progressively increases, however, with a corresponding fall in the hydrogen ion concentration of the blood. When oxygen is insufflated under pressure, they claimed that even the carbon dioxide tension can be kept down to normal levels.

Consideration was given to the use of the electrophrenic respirator to maintain respiratory movements if spontaneous efforts cease. According to Sarnoff (15), normal physiologic levels of alveolar oxygen and carbon dioxide could be approximated in this fashion.

SUMMARY

The surgical procedure involving pneumonectomy accompanied by the resection and open anastomosis of the trachea, carina or contralateral bronchial wall under the direct vision of the surgeon creates a problem in the maintenance of anesthesia. Technical surgical dif-

ficulties render the use of a closed endobronchial technic unsatisfactory. The dangers of an open tracheal or bronchial stump are evaluated and discussed. These difficulties have been overcome by the use of a number 14 French endobronchial catheter for institution of an insufflation technic. Traction sutures are utilized to minimize mediastinal movement. Adequate respiratory exchange can be preserved by these measures. A suggestion is made that the electrophrenic respirator be used to augment respirations if apnea occurs during the critical period when respiration cannot be directly controlled.

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