ANAESTHESIA FOR CONSERVATIVE LUNG RESECTION FOR CANCER

BY

A. R. HUNTER

Royal Infirmary, Manchester

The mortality from pneumonectomy for lung cancer is considerable especially when it is performed in the elderly or relatively unfit. Price Thomas (1955) has described an operation designed to reduce this seriously high death rate. It consists essentially in removal of the lobe in which the cancer is growing, together with a portion of the main stem bronchus. The remainder of the lung is conserved and its bronchus is thereafter sutured to the main bronchial tree.

This procedure presents a number of serious problems to the anaesthetist. First, it is necessary that one main bronchus should, if required, be open for a period of up to an hour. Secondly, it greatly helps the surgeon if the lung on the operated side can be deflated, at will. It is most desirable that at the conclusion of the anastomosis any blood in the cavity of the bronchus should be removed by suction and the remaining lung thereafter inflated to fill the pleural cavity. The anastomosis line too must be tested for leakage under water by increasing the gas pressure in the bronchus. The ordinary problems of any chest operation—namely, the control of the spread of sputum, the prevention of mediastinal flap and of paradoxical respiration and the replacement of lost blood—are, of course, of the usual importance in these cases. Lastly, because the operation is often performed primarily because the patient is unfit for pneumonectomy, many of those undergoing it will be rather poor risks in a group of patients who are as a whole often far from well.

THE MECHANICAL PROBLEM

The primary problem in these cases is the maintenance of adequate ventilation after the opening of the bronchial tree. It is possible if no other means is available to use ordinary endotracheal anaesthesia in these cases and to occlude the opened bronchus with a light clamp such as that used for the auricle in mitral valvotomy. The instrument, however, tends to be in the surgeon's way and in any case many believe that even so light a clamp will impair the healing powers of the tissues of the bronchus. It is, however, important to know that this technique will work as there are cases where no other method of anaesthesia is feasible.

Secondly, it is possible to use an orthodox technique of contralateral endobronchial anaesthesia. In the case of an operation on the right lung this involves intubation of the left main bronchus with a suitable tube and the maintenance of anaesthesia using this lung only. Where the left lung is to be operated on, a blocker is placed in the left main bronchus and the right lung only used for anaesthesia which is maintained by the endotracheal route. These methods give perfectly satisfactory results save for one point. It is not easy to inflate and deflate with certainty the lung which is being operated on. The tubes which are especially designed for the purpose have a very narrow lumen to that side which is thus easily blocked by small amounts of sputum. Expansion of the lung then requires the application of dangerous pressure and deflation is nearly impossible.

The only apparatus which affords full control of both lungs during intrapulmonary surgery is the Carlens double lumen tube. With its aid it is possible to maintain endobronchial anaesthesia, using only the contralateral lung while the main bronchus is open. It is, however, also possible to open the chest under what is substantially endotracheal anaesthesia to both lungs and when the bronchial anastomosis is complete to inflate the remaining lobe on that side, to remove any blood or sputum from the bronchus and to test the tightness of the anastomosis by vigorous inflation before the chest is closed. Further, the functional
efficiency of the reconstituted bronchus may be tested. If air passes readily in and out of the remainder of the lung during inflation the suture line is satisfactory. If, however, there is a tendency to trapping of air blown into the conserved lobe, which is indicated when the lobe does not deflate immediately on reducing the pressure in it, the bronchus is either kinked or narrowed by a stitch. Re-anastomosis is then necessary.

A Carlens tube offers an additional advantage. When one lung is out of use for the period of endobronchial anaesthesia, it is allowed to collapse completely. The circulation through it is thus reduced to negligible proportions and shunting scarcely occurs at all. This period of anaesthesia should not therefore be associated with cyanosis. By contrast under endobronchial anaesthesia of the classical type the blocked-off lung remains expanded to a variable degree during the operation and the efficiency of ventilation is sharply diminished by circulatory shunting. In the elderly unfit type of patient in whom this operation is performed this cannot but have adverse effects on the general condition. Also blocking off one lung and collapsing it so that the circulation through it is reduced is substantially equivalent to a functional pneumonectomy. It is thus possible to carry out a rough-and-ready lung function test in cases where it is doubtful whether conservative resection or the more radical procedure of pneumonectomy is indicated by the pathological condition.

**TECHNIQUE OF ANAESTHESIA**

There is nothing original about the technique of anaesthesia employed. Patients are premedicated with papaveretum 20 mg and hyoscine 0.4 mg or with morphine 10 mg and atropine 0.6 mg, depending on their age and physical fitness. Anaesthesia is induced with thiopentone in a dose of 200 to 400 mg together with 30 to 50 mg of suxamethonium. After inflation of the lungs with oxygen the larynx is exposed with a Macintosh laryngoscope and it and the trachea are sprayed with 4 per cent lignocaine containing 1:40,000 adrenaline. The Carlens tube, which has previously had its cuffs tested for leaks under water, and has been freely lubricated with the proprietary 2 per cent lignocaine gel normally used for the urethra, is then passed by the method described by Jenkins (1956). As soon as the cuffs have been inflated and the patient connected to the anaesthetic machine, the connecting tubes to the Carlens are clipped off in turn and a test inflation of each lung is performed to make quite certain that the tube has been properly placed. Thereafter anaesthesia is maintained with nitrous oxide and oxygen together with suitable doses of pethidine and if necessary a little more thiopentone. A blood transfusion is set up before the operation begins. The patient is curarized with d-tubocurarine just before the chest is opened and spontaneous respiration is held in abeyance till the end of the thoracotomy by a combination of myoneural block and as much hyperventilation as is safe. Carbon dioxide absorption with Water's canister is used to facilitate this.

If at the end of the procedure spontaneous breathing is not restored spontaneously, a sharply limited amount of carbon dioxide is administered (10 breaths containing 20 per cent of the gas once only). If this fails to restart breathing 4 ml of nikethamide is injected intravenously. So far this has never failed the author as a means to restore some spontaneous respiration at the end of this or any other operation. When the returning respiration is inefficient sufficient atropine is given to accelerate the pulse visibly and neostigmine is given in a dose of 1.25 mg. If this does not restore full normal breathing an additional 1.25 mg of neostigmine is given with 0.6 mg of atropine in the same syringe.

It is important that full decurarization should be attained in these cases. They awake rapidly on withdrawing the anaesthetic and if the dyspnoea of residual curarization is superimposed on that of a major thoracotomy, their distress may be very great indeed. Secondly, as with every other chest operation, it is vitally important that the patient should be able to cough and thus to clear his bronchial tree as soon as possible after operation.

**DIFFICULTIES**

The whole question of the difficulties and dangers of the Carlens tube has been discussed at length by Jenkins and Clarke (1958) and indeed some of the cases mentioned in their paper form part of this series. There are, however, certain difficulties which assume a special importance in the patient who has one bronchus open. The first of these
is the development of a leak in a cuff. Nothing can in fact be done to anticipate this accident but it will be to some extent avoided if tubes are carefully tested for leaks under water before they are used. Fortunately it is usually the tracheal cuff which gives way and it is possible by pushing the lower jaw back and increasing the gas flow to compensate to some extent at least for the leak. Surgical puncture of the cuff in the left main bronchus is, of course, possible. If this occurs it may prove necessary to withdraw the Carlens tube part way as in left pneumonectomy and to use it simply as an endotracheal tube or to do as Jenkins and Clarke (1958) and replace it with an ordinary cuffed tube in the trachea. The open bronchus must then be clamped and the advantages of the Carlens tube are lost.

Another difficulty in the use of the Carlens tube is displacement of the cuff in the left main bronchus upwards into the trachea. It will often be noticed where the right main bronchus is opened that the hook is no longer in contact with the carina and that the tube has slipped a little way upwards. If during dissection considerable traction is exerted on the hilum of a left lung the relatively mobile bronchus may be dragged past the cuff. The tendency to slipping upwards is thus exaggerated and when the traction is released the cuff may come to lie partly in the lumen of the trachea where it blocks the gas flow to and from the right lung with the production of a total or near total respiratory obstruction there. The anaesthetist appreciates this as a gross increase in the resistance to inflating the right lung and a marked diminution in the return flow of gases when the pressure is released. The accumulation of sputum on the right side will produce the same effect but will usually be preceded by some moist sounds in the tube. Further, if the left cuff is blocking the airway it will usually be impossible to insinuate a suction catheter into the right main bronchus. If upward displacement of the left cuff has occurred the remedy is to stop the operation, deflate both the cuffs and push the Carlens tube down again until it occupies its proper position. The surgeon can give very considerable help both in the diagnosis and treatment of this condition by localizing the lower end of the Carlens tube by palpating it through the wall of the exposed bronchus. Indeed one of the most satisfactory things about the use of this apparatus is the fact that the surgeon can give the anaesthetist so much help in placing the tube in the position appropriate to the stage of the operation.

No sequelae traceable to the introduction of the Carlens tube were noted by Jenkins and Clarke (1958) in their large series nor have there been any in this smaller group. The only difficulty in the author's experience has been that in small women it may prove impossible to pass the size 37 tube beyond the cricoid ring. In such cases the bronchial anastomosis must be performed distal to an auricular clamp placed close to the bifurcation of the trachea, or better under formal endobronchial anaesthesia. There has been no suggestion in these or in any other cases that the passage of the Carlens tube has traumatized the larynx or trachea any more than an ordinary endotracheal tube.

The only real cause for anxiety has been the amount of pressure which it has been necessary to use when ventilating an isolated lung. As the compliance of a single lung ought in fact to be half that of two lungs it is only natural that double the pressure would be required to produce the same tidal exchanges. In a number of cases the inflation pressures were measured with the aid of a capacitance manometer and a 2:1 relationship between the applied pressures did in fact exist (table I).

<table>
<thead>
<tr>
<th>Number of observations</th>
<th>Inflation pressure (mm Hg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inflating both sides</td>
<td>17</td>
</tr>
<tr>
<td>Inflating one side only</td>
<td>14</td>
</tr>
</tbody>
</table>

Many anaesthetists are concerned about the relative narrowness of the Carlens tube as a cause of these high inflation pressures but this is of minor importance compared with the reduction in compliance produced by cutting out one lung. In any case as far as the inspiratory stroke is concerned the anaesthetist's hand can compensate without difficulty for any resistance generated in the tube. The influence of the tube on expiration can largely be overcome by allowing a long ex-
piratory period for full passive deflation. Fortunately in the lateral position the weight of the mediastinal viscera aid in this process. This same pattern of inflation will serve to minimize the circulatory effects of the increased inflation pressure which in these circumstances can affect only the circulation in the pulmonary capillaries. The more serious disturbances due to the exertion of excessive pressure on a closed chest are due to interruption of the gradient on which the venous return depends, and cannot occur as long as one side of the mediastinum is at atmospheric pressure. In any case fall in systemic blood pressure and rise in pulse rate always provide a clear indication of upsets of the circulation due to over-forceful inflation. In the cases of this series, however, the change from ordinary anaesthesia to that involving one lung only has not been associated with disturbances of this type.

The cases on which this report is based numbered 41 and the surgical results are being reported by Jones (1958) elsewhere. There was no mortality or morbidity in the postoperative period traceable to the anaesthesia.

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REFERENCES

Jones, P. H. (1958). (To be published.)

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**DR. A. B. NOBLE**

*Director of Anaesthesia, Royal Victoria Hospital,*

*Assistant Professor of Anaesthesia, McGill University.*