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Post lobectomy atelectasis: the use of a Servo 900 B as a high-frequency ventilator

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Abstract. High-frequency ventilation (HFV) has been used with good results in a variety of clinical situations where conventional ventilation has proved ineffective. However, all of the reports so far have involved the use of a specially purchased specifically designed ventilator which tends to be unfamiliar to most medical and nursing staff responsible for its use. A case where HFV was used in combination with differential lung ventilation in the treatment of unilateral pulmonary atelectasis is described using a Servo 900B as the high-frequency ventilator. It serves to demonstrate that the Servo 900B can be used as an occasional high-frequency ventilator as required, thus avoiding the expense of purchasing a specialized ventilator.

Key words: Ventilation – Differential lung – High frequency – Complications – Atelectasis – Intensive care

Case history

A 63-year-old man presented for thoracotomy and removal of a left lower lobe carcinoma. He had a history of chronic obstructive airway disease with increasing shortness of breath. Respiratory function tests were poor, with a vital capacity of 3.6 l (predicted 4.68 l) and a forced expiratory volume in 1 s of 0.92 l. Blood gas analysis was pCO_2 5.9 kPa and pO_2 8.3 kPa. Due to the reduction in his respiratory reserves, it was considered essential to limit surgery to a lobectomy.

The operation was completed without mishap and he was admitted to the Intensive Care Unit and ventilated overnight. The following morning he was fully conscious and free of pain and was weaned from ventilation, breathing quietly on continous positive airway pressure (CPAP – 6 cm H_2O). However, blood gas analysis showed an arterial pO_2 of 5.6 kPa (FIO_2 0.4) and chest X-ray revealed complete collapse of the remaining left lung with apical and basal pneumothoracies (Fig. 1). He was reventilated with a marginal improvement in arterial pO_2. The chest drain positioned at the time of surgery was replaced by a new one introduced percutaneously. His oxygenation failed to improve despite physiotherapy and a decision was made to try asynchronous independent lung ventilation (AILV). This involved endobronchial intubation with a "Bronchocath" double-lumen tube (National Catheter Company, Argyll, NY). The right lung was ventilated conventionally with a Servo 900B set to deliver a minute volume of 8.0 l at a frequency of 20 breaths/min. The left lung, however proved to

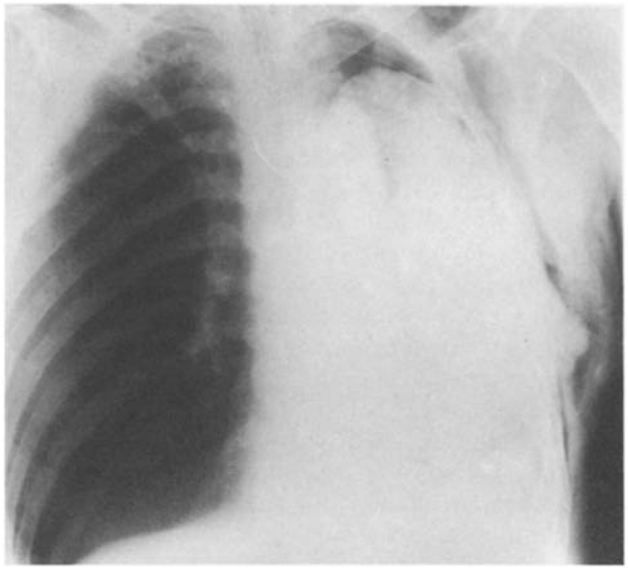

Fig. 1. Chest X-ray revealing complete collapse of remaining left lung

Fig. 2. Chest X-ray showing partial re-expansion of left lung

be impossible to inflate without an excessive inspiratory pressure (greater than 60 cm H_2O) and so CPAP of 20 cm H_2O was applied using another Servo 900B. Both ventilators were set to deliver 50% oxygen and this resulted in a good blood gas analysis (pO_2 12.1 kPa, pCO_2 6.0 kPa FIO_2 0.5). Unfortunately, a large air leak developed from the chest drain and it was feared that the bronchial suture line had been disrupted by the application of CPAP to the operated lung.

Early next morning blood gas analysis had deteriorated (pO_2 8.9 kPa, pCO_2 7.6 kPa FIO_2 0.5) and chest X-ray showed partial re-expansion of the left lung (Fig. 2). Because of the obviously increased ventilation perfusion abnormality through this lung, it was felt that high frequency ventilation (HFV) would be useful in normalizing blood gas analysis. This was achieved using the same Servo 900B ventilator used to provide CPAP by turning the frequency control to maximum (60 breaths/min), removing the PEEP, and increasing the trigger level to 10 cm H_2O. This resulted in the Servo delivering approximately 120 breaths/min with a peak inspiratory pressure of 12 cm H_2O. Blood gas analysis improved rapidly and allowed the inspired oxygen concentration to be reduced to 40% (pO_2 10.9 kPa, pCO_2 5.6 kPa FIO_2 0.4).

The air leak persisted and a rethoracotomy was performed. Here it was discovered that the new chest drain, inserted percutaneously, had penetrated the lung causing the leak. The bronchial suture line was intact. The lung was surgically repaired and the leak ceased.

The lung re-expanded fully and HFV was discontinued 51 h after it began. AILV was continued for a further 12 h before the double-lumen tube was replaced by an ordinary endotracheal tube, and conventional ventilation was resumed. Two further attempts were required to wean the patient from mechanical ventilation, but this was successful and he left the intensive care unit 10 days after admission. His blood gas analysis was good (pO_2 14 kPa, pCO_2 5.7 kPa FIO_2 0.4), and his chest X-ray compatible with his surgery.

Discussion

Atelectasis is not uncommon after thoracic surgery and conventional therapy involves adequate pain relief, physiotherapy, antibiotics and postural drainage. However, in this case, the presence of hypoxaemia demanded a more urgent solution to the problem. Techniques previously described to overcome this problem include the use of a fibreoptic bronchoscope modified to introduce a removable trachyostomy cuff [2] and the application of a high positive pressure via a double-lumen tube [3]. Both of these techniques require at least 60 cm H_2O pressure, with the potential problem of suture line disruption if used after bronchial surgery. The technique described in this report utilizes a more gentle approach (20 cm H_2O pressure), combined with HFV to normalize blood gas values during the slower period of lung reinflation. It also allowed the use of low inspired oxygen concentration (FIO_2 0.4), thus avoiding potential problems of pulmonary oxygen toxicity [1].

The availability of implant tested double-lumen tubes has made prolonged endobronchial intubation an accepted technique, having been used for up to a week via a formal trachyostomy [4] and up to 10 days using the orotracheal route in this department.

A further consideration of this report is that the Servo 900B can be used as an occasional high-frequency ventilator. HFV has been used in the treatment of acute respiratory failure where conventional ventilation has failed [5], but all reports so far have involved the use of a specially designed ventilator specifically acquired for HFV. Such a ventilator, although proven to be potentially life saving, usually lies unused for the majority of the time. This report demonstrates that a commonly available intensive care ventilator, the Servo 900B, can be used as a high-frequency ventilator as the need arises. Further, the ventilator is used in an unmodified form and thus is familiar to the medical and nursing staff involved. Naturally, the same ventilator can be used conventionally at other times. The Servo 900B used as the high frequency ventilator was examined closely afterwards and showed no signs of obvious damage having occurred during the 51 h of HFV.

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Book review

Mosby's comprehensive review of critical care. D. A. Zschoche (ed) Blackwell Scientific, Oxford 1986. 377 figures, £ 30.50

This is the third edition of Mosby's comprehensive review of critical care, edited by Donna A. Zschoche, Director of Education at the National Critical Care Institute of Education at Ramona, California. There are 63 contributors including nurses, physicians, pharmacists, social workers and surgeons, all directly involved with the care of critically ill patients. The book is a large format soft cover book which weigh a hefty 1.7 kg. Its 47 chapters are arranged in 13 units. The chapters are structured in a question and answer format and are well illustrated with line drawings, black and white photographs, ECGs and angiograms. Each chapter is extensively referenced, with references as recent as 1984 appearing. The preface states this book is intended for the practicing critical care clinician rather than the novice. It utilises the philosophy of the "whole body" system and multi-organ approach. Despite its claims to be aimed at all critical care personnel it has a marked nursing bias. The first unit on physiological and psychosocial aspects of critical care begins with a chapter on basic histology, anatomy and physiology. It includes a detailed discussion of cell structure and histology, much of which is irrelevant to the subject of critical care and may be found in any standard biology text book. Some sections of the physiology are oversimplified, viz page 17 "in the normal heart beat *lub dub,* the lub is caused by closure". Professor Chrisman's chapter on trans-cultural care provides a fascinating over view of patient/practitioner relationships. We would all do well to read it and re-appraise our own attitudes towards patients of different cultural backgrounds. Respiratory medicine is extensively covered and includes chapters on hyperbaric oxygen therapy, high frequency positive pressure ventilation and weaning from PEEP. These chapters are clearly written, are very practical, authoritative, perhaps to the point of being didactic clearly reflect local practice. The section on cardiology has a heavy nursing bias. This part of the book shows the inevitable repition of a multi-author book. Surprisingly, although thrombolytic agents are discussed, there is no mention of plasminogen. Heart transplantation is covered briefly but heart/lung transplantation and ventricular assist/artificial heart devices are not discussed. Dr. Severence's chapter on pancreatitis has little to offer the critical care practitioner. Peritoneal lavage is dismissed in a single sentence and emergency ERP is not mentioned. Several contemporary issues are discussed and include the inevitable chapter on computerization in critical care. Professor Volteri's discussion of prognosis for survival does not dwell on scoring systems, rather it concentrates on the rather more ethical issues. I would be nit picking if I listed the faults in this book, one or two areas are worthy of mention. I am not sure of the place of discussions on stroke and cardiac rehabilitation in a text book of critical care. The occasional contentious (and unsubstantiated) statement have crept in viz "N-acetyl cysteine ... is effective in thinning extremely viscid tracheo-bronchial secretions". In conclusion this is a useful and practically orientated book. It should help fill the gap between the pocket books e. g. Hansons 'Intensive Therapy' and the standard work such as Tinker and Rapins "Care of the critically ill patient". Despite its obvious nursing slant the book contains much that would be useful to an intensive care Houseman or junior Registrar. It should be on the shelves of every intensive care unit nursing library.

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