Spontaneous breathing combined with high frequency ventilation during bronchoscopic resection of a large tracheal tumour

M. Satoh*, Y. Hirabayashi and N. Seo

Department of Anaesthesiology, Jichi Medical School, Minamikawachi-machi, Tochigi, 329–0498, Japan

*Corresponding author

A patient with learning difficulties had a large tracheal tumour at the carina that caused severe respiratory distress. I.v. anaesthesia with propofol, spontaneous breathing through a tracheal tube, and high frequency jet ventilation were successfully employed during bronchoscopic resection of the tumour.

Keywords: airway, obstruction; anaesthetics i.v., propofol; complications, learning difficulties; complications, respiratory; intubation, tracheal; ventilation, high frequency jet

Accepted for publication: May 24, 2002

Primary tracheal tumours are uncommon.1 The risk of respiratory distress is related to the size, location and shape of the tumour. Although resection of tracheal tumours in conscious patients using the fibreoptic bronchoscope is an effective and less invasive therapeutic option than thoracotomy, the associated management of the airway can prove difficult.

We describe a patient with learning difficulties who had severe airway obstruction secondary to a large tracheal tumour at the carina. In this case, spontaneous breathing during general anaesthesia, combined with high frequency jet ventilation (HFJV), was effective and facilitated the successful resection of the tumour through a tracheal tube.

Case report

A 28-yr-old man (weight, 83 kg; height, 178 cm) gave a 6-month history of a non-productive cough and wheezing. His medical history included learning difficulties secondary to neonatal hypoxic encephalopathy. His mental age was judged to be that of a 4-yr-old. As a result, he was unable to articulate his symptoms effectively and a physician initially treated him for an upper respiratory tract infection. He subsequently developed a sudden attack of severe respiratory distress early in the morning, and his family brought him to our hospital. A chest x-ray revealed a large tracheal tumour at the carina, which almost completely occluded the tracheal lumen. A thoracic CT scan demonstrated a 17.8 mm \( \times \) 21.5 mm \( \times \) 26.5 mm mass that was attached by a stalk to the anterior wall of the carina. Ninety-two per cent of the cross-sectional area of the trachea was obstructed by tumour (Fig. 1). The patient was kept in the left lateral decubitus position because his respiratory distress worsened in the right lateral decubitus and supine positions. Finger pulse oximetry (\( S_{\text{pO}_2} \)) showed an oxygen saturation of 94–96% when he received oxygen 2 litres min \(^{-1} \) by face-mask. The patient refused arterial blood gas sampling. A decision was made to resect the tumour under general anaesthesia using the fibreoptic bronchoscope.

The patient was premedicated with famotidine 20 mg intravenously 30 min before induction of anaesthesia. On arrival in the operation room, his heart rate was 100 beats min \(^{-1} \), arterial pressure was 145/75 mm Hg and \( S_{\text{pO}_2} \) was 94%.

Prior to induction of anaesthesia, we prepared a jet ventilation catheter, and tracheostomy instruments in case of complications. The patient inhaled oxygen 100% for 10 min whilst in the left lateral decubitus position and was then turned to the supine position. Anaesthesia was induced with propofol 200 mg and manual ventilation via a facemask was started. Physical examination suggested a reduction in right chest wall movement at this time and the \( S_{\text{pO}_2} \) fell from 100 to 95%. Succinylcholine 140 mg was administered to facilitate oro-tracheal intubation with a cuffed tube (internal diameter, 8.5 mm). The lungs were ventilated through the tracheal tube using a high frequency jet ventilator (driving pressure, 1.0 kgf cm \(^{-2} \); I/E ratio, 0.33; rate, 60–120 min \(^{-1} \); \( F_{\text{I}_2} \), 0.3–1.0). Bilateral chest wall movement was restored.
after spontaneous breathing had resumed. We decided to allow the patient to continue to breathe spontaneously. Anaesthesia was maintained with propofol 6 mg kg\(^{-1}\) h\(^{-1}\) and buprenorphine 0.2 mg intravenously.

Prior to the bronchoscopic procedure, the trachea was topically anaesthetized with lidocaine 2% (total dose, 400 mg) via the tracheal tube. The operation was performed with a fiberoptic bronchoscope (external diameter, 6 mm) via the tracheal tube. HFJV was then performed through a 10-Fr suction catheter, which was passed through the same tracheal tube for 2 cm into the left main bronchus. Whenever the \(S_pO_2\) fell below 95%, the bronchoscopic procedure was temporarily halted and ventilation was gently assisted. This occurred three times during HFJV. As the \(S_pO_2\) also fell if the driving pressure was reduced, we set the driving pressure at 1.0 kgf cm\(^{-2}\). As a result, the \(S_pO_2\) did not then fall below 93% at any stage. Arterial blood pressure remained at 100–120/45–60 mm Hg whilst the heart rate was between 80 and 100 beats min\(^{-1}\). There were no ECG changes throughout the procedure. Arterial blood gas analysis revealed a \(P_aO_2\) of 10.8 kPa, a \(P_aCO_2\) of 7.8 kPa and a pH of 7.31 when the \(S_pO_2\) fell to its lowest value of 93% during the operation.

The stalk of the tumour was cauterized. The surgeons then removed the tumour, together with the tracheal tube, using a basket catheter because the tumour was too large to pass through the tracheal tube. Following successful removal of the tumour and the tracheal tube, the patient developed laryngospasm. Vecuronium bromide 10 mg and hydrocortisone sodium succinate 500 mg were administered intravenously and another tracheal tube (internal diameter, 7.5 mm) was inserted. The surgeons confirmed complete resection of the tumour by fiberoptic bronchoscopy. Chest wall movement was symmetrical soon after the operation had been completed and the lungs were artificially ventilated for a further 30 min. The second tracheal tube was removed following administration of neostigmine 2.5 mg and atropine 1.0 mg to antagonize any residual neuromuscular block. The operation lasted 70 min. The total durations of anaesthesia and HFJV were 150 min and 53 min, respectively. The patient developed no further airway problems following the surgery.

**Discussion**

The first challenge of this clinical case was the method to be used to control the airway. Adults usually undergo fiberoptic examination whilst awake since this is safer than being under general anaesthetic. However, in children or individuals with significant learning difficulties, this approach is problematic. Because of the patient’s limited intellectual capacity, we judged that it would prove impossible to use a fiberoptic technique for the surgery whilst he was awake. In addition, the surgeons informed the anaesthetists that several patient positions, including prone, lateral, semi-erect and supine positions, would be required during bronchoscopic resection of the tumour. We therefore decided to use general anaesthesia and a tracheal tube rather than a laryngeal mask airway for this patient. In view of the proposed surgical procedure, we used the largest tracheal tube available. Using a tracheal tube does carry a risk of massive bleeding from the tracheal tumour in such cases. However, in this patient, the CT scan demonstrated that the tumour was located at the carina and that there was sufficient distance between the vocal cords and the tumour to allow safe insertion of a tracheal tube.

The second challenge of the case related to the method of ventilation used during the bronchoscopic procedure. Spontaneous breathing has frequently been recommended during anaesthesia in such circumstances, to avoid airway obstruction resulting from muscle paralysis or positive pressure ventilation.\(^2\) In our patient, we noted that move-
ment of the right chest wall worsened during positive pressure ventilation on induction of anaesthesia. It was thought that right main bronchus obstruction had been induced by the artificial ventilation, resulting in dynamic hyperinflation. We therefore allowed spontaneous breathing during surgery and applied HFJV in order to assist ventilation effectively.2 The disadvantages of this technique can include ineffective ventilation and a potential hindrance to surgery. Bronchoscopy indicated that the spherical tumour almost completely blocked the right main bronchus and so the HFJV catheter was passed about 2 cm into the left main bronchus. In this way, we were able to prevent hyperinflation of the right lung and allow optimal access to the surgical field.

The other method of managing hypoxaemia during one-lung ventilation is continuous positive airway pressure (CPAP). However, it has been reported that CPAP does not generate sufficient alveolar oxygen tension in the non-ventilated lung to prevent hypoxaemia in patients with bronchial obstruction.6 Studies by Slinger and colleagues4,5 reported that the side of the ventilated lung was an important factor in this respect; the efficiency of oxygenation and of gas exchange was better when the right lung rather than the left lung was ventilated during one-lung ventilation. Although in this case only the left lung was ventilated, we were able to use HFJV with a 10-Fr suction catheter and a $F_{O_2}$ of only 0.3 during the procedure. The effects of HFJV on oxygenation and gas exchange were not determined since neither the flux nor the pressure were measured. However, we considered that HFJV supported breathing effectively and did not hinder spontaneous breathing in this case.

Helium–oxygen mixtures are commercially available and may be useful in the emergency department to treat patients with airway obstruction.6–7 Breathing a mixture of helium and oxygen leads to a reduction in the resistance to flow within the airways, and consequently results in a decrease in the work involved in breathing. Whether awake or asleep, our patient showed a deterioration in his condition when his position was changed. Although helium would have been potentially useful, it is not available for such treatment in Japan. It might have been an excellent method of allowing spontaneous breathing in combination with HFJV.

The third aspect of this case for consideration was the anaesthetic agents used. Anaesthetic induction with inhalational agents is usually regarded as the technique of choice in view of its safety.2 Nevertheless, adverse events have been reported with this technique.8 Using the i.v. anaesthetic agent, propofol, we were able to maintain the depth of anaesthesia more readily than with inhaled anaesthetic agents. It has been reported that the respiratory depressant effects of propofol 6 mg kg$^{-1}$ h$^{-1}$ are clinically acceptable and we selected an i.v. anaesthetic technique for these reasons.

We applied topical anaesthetic to the trachea and bronchus in order to prevent adverse reflexes during the fibreoptic bronchoscopy. The surgeons removed the tumour with the tracheal tube, contrary to our expectations. Unfortunately, the larynx had been insufficiently anaesthetized to prevent laryngospasm after extubation.

In summary, this case report describes the anaesthetic management of a patient with learning difficulties who successfully underwent bronchoscopic resection of a large tracheal tumour. During the procedure, i.v. anaesthesia with propofol and spontaneous breathing, combined with HFJV, allowed effective management of the airway.

References