CASE REPORT

Recruitment bronchoscopy by trans-glottic approach successfully treated lung collapse in an intubated mechanically ventilated patient

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SUMMARY

Pulmonary lower lobe atelectasis/collapse is a common problem in patients undergoing mechanical ventilation. It also occurs in non-intubated patients with traumatic brain or spinal cord injuries, morbid obesities and chest wall disorders. Conventional manoeuvres such as chest physiotherapy, bronchodilators and positive-end expiratory pressure (PEEP) administration are frequently used in its management with variable success rates. However, despite the reported success of bronchoscopic recruitment manoeuvres, selective intrabronchial air insufflation during fiberoptic bronchoscopy to re-expand collapsed lungs is an underutilised practice. Here, we report an example of successful selective intrabronchial air insufflation in an intubated patient with bilateral lower lobe collapses after surgery for an incarcerated hernia. To our knowledge, this is the first successful report of recruitment manoeuvre by trans-glottic bronchoscopy in an intubated, mechanically ventilated patient.

BACKGROUND

Pulmonary lobar/segmental collapse is a common problem in critically ill patients under mechanical ventilation, those with traumatic brain/spinal cord injuries and those with chest wall disorders. Chest physiotherapy, mucus plug removal and the administration of positive-end expiratory pressure (PEEP) are commonly used to prevent or treat lobar atelectasis with variable success rates. However, these manoeuvres cannot be performed for all patients. For example, chest physiotherapy cannot be carried out easily on patients with flail chest. PEEP administration may have adverse haemodynamic effects and increase the trans-pleural pressure in both collapsed and non-collapsed regions. The ensuing hyperinflation of normal alveoli may further compress the adjacent collapsed alveoli.^{1 2}

Theoretically, selective administration of positive pressure with air insufflation into segmental and subsegmental bronchi of the collapsed region using fiberoptic bronchoscopy could be more effective with less desirable side effects. Here, we report a successful bronchoscopic recruitment manoeuvre using the Tsao *et al*'s³ method in a 61-year-old intubated patient via nasal path and trans-glottically.

To our knowledge, it is the first detailed report of successful selective intrabronchial air insufflation by the Tsao method in an intubated patient carried

out transnasally in order not to interfere with mechanical ventilation.

CASE PRESENTATION

The patient was a 61-year-old male smoker with a history of chronic obstructive pulmonary disease who was admitted into intensive care unit (ICU) after surgery for an incarcerated umbilical hernia. He had a dull generalised abdominal pain for 3 days before admission. On the day of admission, he developed anorexia, vomiting and obstipation. Soon after, he was diagnosed of complete intestinal obstruction due to an incarcerated umbilical hernia. The first 2 days after operation was uneventful and he was under mechanical ventilation on volume-assist control mode. On the third day, he developed hypoxaemia despite increasing fraction of inspired O₂ and PEEP.

INVESTIGATIONS

Chest imaging on the same day showed atelectasis of lower lobes and small-sized pleural effusion on the left (figure 1). Findings of echocardiography and serum cardiac biomarkers were normal. There was no evidence of acute pulmonary oedema or acute lung injury on chest imaging. Acute pulmonary thromboembolism was less probable because of the presence of lobar collapse on chest imaging.

DIFFERENTIAL DIAGNOSIS

Acute pulmonary thromboembolism, acute lung injury, acute pulmonary oedema and lung atelectasis.

Figure 1 Chest X-ray showing lower lobe collapses and small-sized pleural effusion on the left side.

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Figure 2 Schematic illustration showing how passage of the bronchoscope through the endotracheal tube may interfere with the patient's ventilation by increasing the tube resistance.

TREATMENT

Chest physiotherapy, nebulised bronchodilators, mucus suction and recruitment manoeuvres including high PEEP and high inspiratory pressures (20–30 cm H₂O for 2 min) were unsuccessful. There was no evidence of respiratory tract infection based on clinical data and quantitative tracheal aspirate culture.

The patient was transferred to the bronchoscopic unit and ventilated via an anaesthetic machine without PEEP. His vital signs and arterial oxygen saturation (SaO₂) were monitored and recorded every 2 min. The initial attempt to pass the fiberoptic bronchoscope through the endotracheal tube (8 mm internal diameter) was unsuccessful because of progressive decrease in SaO₂ (figure 2). The recruitment manoeuvre was assumed to take more than half an hour so it was prudent to select an approach with the least compromise in the patient's ventilation. Therefore, selective intrabronchial air insufflation was carried out by flexible bronchoscope trans-glottically (figure 3). In this approach, the bronchoscope inserted through the nose and then

Figure 3 Schematic illustration showing the insertion of the bronchoscope transnasally and its passage into the tracheobronchial tree alongside the endotracheal tube with least interference with the patient's mechanical ventilation.

(a)

(b)

Figure 4 (A,B) Equipment used in recruitment bronchoscopy manoeuvre.

trans-glottically alongside the patient's endotracheal tube. Segmental/subsegmental bronchi on both sides were wedged individually by the bronchoscope. Once the passage of scope was impeded, intrabronchial air insufflation was carried out by compressing the 0.5 L adult resuscitation bag connected to the working channel of the bronchoscope and to a manometer (figure 4A,B). Thirty centimetre H₂O pressures were applied for 60 s over each bronchial segment/subsegment. The entire procedure lasted about 1 h. During the recruitment procedure, there was no significant change in the patient's pulse rate, O₂ saturation or blood pressure.

OUTCOME AND FOLLOW-UP

The day after procedure, the new chest X-ray showed near-complete recruitment of lower lobes (figure 5) and he was successfully weaned from mechanical ventilation 2 days later. He was moved from ICU to surgical ward 24 h later.

DISCUSSION

The selective intrabronchial recruitment manoeuvre was first deployed by using balloon-tip catheters. It was successful in 60–90% of patients with lobar collapses. Tsao *et al* used a simple method of selective intrabronchial room air insufflation to re-expand collapsed lung by using an ambo bag connected to a suction channel of a fiberoptic bronchoscope. The manoeuvre was completely successful in re-expanding the collapsed lobes

Figure 5 Chest X-ray showing re-expansion of lower lobes after recruitment bronchoscopy.

in 12 of 14 procedures.³ Since the introduction of the Tsao method, there are few reports of performing this bronchoscopic recruitment manoeuvre in critically ill patients and other recruitment manoeuvres were carried out in different ways with variable success rate. For instance, Cavaliere *et al*⁴ reported the successful manual re-expansion of a localised atelectasis guided by chest ultrasonography; during recruitment, they applied high inspiratory pressure (60 cm H₂O). They used bed-side ultrasonography to minimise the time the atelectatic lung exposed to high pressures. In another successful report of selective intrabronchial air insufflation in surgical ICU patient, Wohlaue *et al*⁵ used 5–10 positive pressure breaths to every segment of collapsed lobe with an adult resuscitation bag.

Since the patient's characteristics including lung mechanical variables and regional lung constant time affect the recruitment manoeuvre outcome, it is prudent to monitor measurable objective parameters such as duration and the amount of positive pressure applied to re-expand the collapsed lobes. Therefore, we aimed to limit applied positive pressure to a pre-determined level of 30 cm H₂O, as recommended by Tsao *et al*.^{3–6} We used available equipments in the bronchoscopic unit such as a 500 cc resuscitation bag, a three-way connector, a blood pressure manometer, an extension tube and an airway adaptor to deliver such pressure to each bronchial segment of collapsed lobes. As the set pressure limit was constant, the regional time constant determined the volume of air delivered to each bronchial segment. Therefore, the probability of such complications as volutrauma would decline. Also, passing the bronchoscope trans-glottically (figure 3) had little interference with the patient's ventilation and our patient had no sign of haemodynamic instability or desaturation during or after the procedure.

In previous reports, all bronchoscopic recruiting manoeuvre in intubated patients were carried out by passing the

bronchoscope through the endotracheal tube (figure 2) using a swivel adaptor connected to the tube. This approach could not be performed in our patient due to worsening hypoxaemia. To our knowledge, this is the first recruiting manoeuvre where the bronchoscopy was carried out trans-glottically in a patient under mechanical ventilation. This approach produces the least interference with the patient's mechanical ventilation^{7–8} and allowed uninterrupted prolonged bronchoscopy up to 1 h for wedging of the bronchoscope and introducing the pressure in all collapsed segmental/subsegmental bronchi.

In conclusion, this report shows that recruiting manoeuvre performed by trans-glottic bronchoscopy in intubated mechanically ventilated patients using the Tsao method could safely re-expand the collapsed lobes without interfering with the patient's ventilation.

Learning points

- ▶ Recruitment bronchoscopy is a procedure of selective interbronchial air insufflation in order to re-expand collapsed lungs.
- ▶ Recruitment bronchoscopy may expedite weaning of mechanically ventilated patients with regional atelectasis.
- ▶ Recruitment bronchoscopy can be safely carried out for a prolonged period in intubated mechanically ventilated patients by a trans-glottic approach without interfering with patient's ventilation.

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