Pressure support ventilation with the laryngeal mask airway: a method to manage severe reactive airway disease postoperatively

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The use of a laryngeal mask airway (LMA) and a bi-level positive airway pressure (BiPAP®) machine is described in a postoperative thoracotomy patient with reactive airway disease. The LMA was placed to avoid reintubation of the trachea after a double lumen tube was no longer necessary. Placement in an awakening patient and positive-pressure ventilatory support were well tolerated and did not trigger a bronchospastic response. The patient was able to cough and breathe deeply with the LMA while receiving ventilatory assistance in the post-anaesthesia care unit (PACU). The LMA is a therapeutic option to tracheal reintubation in patients who need postoperative ventilatory support after one-lung anaesthesia.

Le masque laryngé (ML) associé à un appareil de pression positive à deux paliers (BIPAP®) est utilisé après une thoracotomie chez un patient souffrant d'une hyperéactivité des voies respiratoires. Le ML est installé pour éviter une réintubation trachéale après l'ablation de la canule bronchique à deux lumières. La mise en place en phase de réveil et l'aide ventilatoire sont bien tolérées et ne déclenchent pas de bronchospasme. A l'unité de soins postanesthésique, le patient est capable de tousser et de respirer profondément avec un ML. Le ML peut remplacer la réintubation trachéale chez les patients dont l'état nécessite une assistance ventilatoire après une anesthésie unipulmonaire.

Key words

AIRWAY: reactive, resistance;
COMPLICATIONS: bronchospasm, intubation;
EQUIPMENT: laryngeal mask airway, BiPAP®; double lumen tube;
VENTILATION: positive pressure.

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Asthmatics and other patients with reactive airways disease are at increased risk of bronchospasm during intubation, extubation and other manipulations of their airways. It has been suggested that airway reflexes be depressed before tracheal intubation in these patients to prevent life-threatening bronchoconstriction. There may also be some benefit in removing the endotracheal tube during anaesthesia while the airway reflexes are still attenuated, if this can be done without increasing risk.[1]

In thoracic surgery, a double-lumen tracheal-endobronchial tube is often used to facilitate one-lung ventilation. These tubes offer more resistance to spontaneous breathing and stimulate not only the trachea but also the carina and a main stem bronchus. They are often replaced by a large diameter, single-lumen endotracheal tube if postoperative ventilatory support is required. However, these tubes remain a source of tracheal irritation on emergence.

We report the management of a patient with reactive lung disease who needed postoperative ventilatory assistance but was able to benefit from tracheal extubation under deep anaesthesia by using a laryngeal mask airway (LMA) with inspiratory and expiratory positive-pressure ventilatory assistance in the PACU provided by the BiPAP® pressure support system (Respironics, Murrysville, PA).

Case report

A 71-yr-old man underwent open lung biopsy and left upper lobectomy for a solitary nodule on chest *x*-ray and CT scan. He had a 138 pack-year history of cigarette smoking, and severe reactive airway disease requiring hospitalization and mechanical ventilation within the last year. He also suffered from mild adult onset diabetes. Pertinent laboratory results included $PaCO_2$ of 39 mmHg with a PaO_2 of 57 mmHg while breathing room air. Medications included theophylline, prednisone, bumetanide,

and glipizide. The patient received intravenous hydrocortisone succinate (100 mg) preoperatively.

Intubation was performed uneventfully with a #39 left double lumen Robertshaw tube after a fentanyl (5 $\mu g \cdot kg^{-1}$) and thiopentone (4 $mg \cdot kg^{-1}$) induction with vecuronium for muscle relaxation. Immediately after intubation the patient developed wheezing that easily responded to additional fentanyl (100 μg), thiopentone (125 mg) respectively, and the addition of 2% isoflurane. Flexible fibreoptic bronchoscopy confirmed correct placement of the double lumen tube. Surgery proceeded uneventfully. Anaesthesia was maintained with air, oxygen (80%), isoflurane and opioids. Satisfactory oxygenation and ventilation were confirmed with continuous pulse oximetry and capnography. At the completion of surgery, reversal of neuromuscular blockade with neostigmine (3 mg) and glycopyrrolate (0.6 mg) was confirmed by four equal adductor pollicis muscle contractions to train-of-four ulnar nerve stimulation with no tetanic fade. To avoid repeating the bronchospasm seen earlier, extubation during deep anaesthesia was performed. Soon after extubation it became clear that the patient would require ventilatory assistance. There was discordant motion of the abdomen and chest with splinting and rapid shallow breathing. Rather than reintubate the trachea and allow the patient to awaken with a foreign body in his trachea, which might trigger a bronchoconstrictive response, an LMA was inserted after topical anaesthesia was applied to the oropharynx, and its cuff inflated. This was followed by breath holding for 30 sec before spontaneous breathing resumed. Positive pressures of 22 cm/H_2O could be generated without a leak.

Ventilation was assisted as the patient was brought to PACU. The LMA was then connected to a BiPAP® machine set to deliver 7 cm H_2O expiratory positive airway pressure (EPAP) and 15 cm H_2O inspiratory positive airway pressure (IPAP). Oxygen was added into the inspiratory circuit at 7 $L \cdot min^{-1}$. The patient tolerated this intervention well. Arterial blood gas analysis after 30 min of ventilation revealed a pH 7.4, $PaCO_2$ 44 mmHg, and PaO_2 78 mmHg. After treatment of severe incisional pain with intercostal nerve block and morphine *iv*, the patient could breathe deeply, cough up secretions, demonstrate a head lift for >10 sec, and was awake. The LMA was removed 90 min after its insertion. The SpO_2 decreased from 96% to 90% but was improved by encouraging the patient to cough and by the application of 60% O_2 via face mask. The patient left the PACU comfortable with an oxygen saturation in the mid 90's. Chest *x*-ray taken ten minutes after assisted LMA breathing showed no gastric air. The patient had an uneventful postoperative course.

Discussion

An LMA was chosen to secure this patient's failing airway because it does not cause any direct tracheal stimulation while maintaining a patent airway better than a face mask. It permits coughing and clearing of secretions without the need for tracheal suctioning and its irritation. As the patient was breathing spontaneously, EPAP and IPAP support were considered the most appropriate and comfortable respiratory interventions.

The BiPAP® pressure support system was used for this patient because the machine was designed to provide ventilatory assistance to patients wearing a tight-fitting nasal CPAP mask. During inspiration, it supplies a preset level of inspiratory pressure that is always higher than the expiratory level. Flow data are continually processed and automatic adjustments in triggering thresholds are made because variable circuit leaks are often found with a nasal CPAP mask (as is also the case with an LMA).[2] This allows for rapid adjustments in response to changing leaks. This feature is desirable for ventilator-assisted patients who have an LMA in place by maintaining high sensitivity to inspiratory effort in the face of varying mask leaks.

The BiPAP® machine is smaller and less expensive than conventional ventilators and is useful in the treatment of acute and chronic respiratory failure,[3] sleep apnoea,[4] and congestive heart failure.[5] This is the first reported case of its use in the PACU or with an LMA.

While receiving respiratory assistance in the PACU the patient was allowed to awaken. No wheezing or respiratory distress was noted. Pain therapy was optimized to allow good tidal volumes and coughing.

Placing the LMA after removal of the double lumen tube was simple and well tolerated by the patient. Haemodynamic stability during LMA insertion has been well described by other investigators.[6] Others have shown that haemodynamic changes during emergence are less with an LMA than with an endotracheal tube.[7,8] Thus, the use of an LMA to support respirations during the postoperative period is less traumatic to the airway, cardiovascular and respiratory systems than reintubation at the times of insertion and removal.

Maintenance of lung volume and the prevention of atelectasis which often complicates thoracic surgery made EPAP desirable. Breathing was assisted with IPAP until the patient was pain-free and awake enough to generate a tidal volume consistent with good ventilation. Although a concern, gastric dilatation[2,9] did not develop with this form of assisted ventilation used in conjunction with the LMA.

In summary, we report a technique for assisting pulmonary ventilation that is less stimulating and invasive

than reintubation. Although tracheal reintubation was a management option, we feel that an LMA led to a smoother emergence and prevented the hyperactive airway response seen at induction with tracheal intubation. The use of a BiPAP® machine in the PACU is also described. We expect the LMA to be used more frequently during emergence and for other indications because of the attenuated airway and haemodynamic reflexes that they produce. The LMA can expand the use of BiPAP® to other hospitalized patients who would normally not be considered candidates for this technique, e.g., facemask intolerant patients, and allow them use of this safe means of assisting patient ventilation in PACU and other hospital locations.

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