Spinal anaesthesia and non-invasive positive pressure ventilation for hip surgery in an obese patient with advanced chronic obstructive pulmonary disease

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We describe the use of non-invasive positive pressure ventilation combined with spinal anaesthesia to allow the insertion of a dynamic hip screw in an obese patient with advanced chronic obstructive pulmonary disease. The technique avoided the hazards of intubation and general anaesthesia in this high-risk patient.


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Obesity and chronic obstructive pulmonary disease (COPD) are two prevalent conditions in the general population that can pose problems to the anaesthetist. Obesity, a condition with an alarmingly increasing occurrence, offers numerous challenges ranging from increased difficulty in intubation, derangement of gas exchange, reduced chest compliance, and increased respiratory resistance. Furthermore, obese patients are often more sensitive to the effects of sedatives, opioids, and anaesthetic agents, slowing the recovery and precipitating respiratory failure.1,2

In patients with COPD, as in obesity, the deleterious effects of anaesthesia are numerous and include worsening of ventilation–perfusion ratios, attenuation of hypoxic pulmonary vasoconstriction, exacerbation of bronchospasm, and a generalized increase in intraoperative and postoperative pulmonary complications.3 Accordingly, those with advanced disease may poorly tolerate any postoperative reduction in lung function or the sedating effects of general anaesthesia or opiates and therefore require a period of postoperative invasive ventilation.4

We present a case where a combination of spinal anaesthesia and non-invasive positive pressure ventilation (NIPPV) was used in an obese patient with severe COPD, pulmonary hypertension, and cor-pulmonale, undergoing the insertion of a dynamic hip screw (DHS). To our knowledge, this is the first case report on the use of this particular combination technique.

Case report

A 76-yr-old female patient, BMI 37 kg m⁻², presented to the hospital for fixation of fracture neck of femur with DHS. She had advanced COPD, cor-pulmonale, and pulmonary arterial hypertension. Her exercise tolerance was 5–10 yards limited by shortness of breath and she was not able to lie flat for more than 10 min. Her preoperative respiratory function tests revealed FEV1 0.7 litre and FEV1/FVC 0.4. Arterial blood gas analysis on room air showed pH 7.45, \( P_{\text{aO2}} \) 8.2 kPa, \( P_{\text{aCO2}} \) 7.3 kPa, and HCO₃⁻ 34 mmol litre⁻¹. Echocardiography showed evidence of right heart failure and moderate pulmonary arterial hypertension (exact pulmonary arterial pressures could not be recorded due to body habitus). Electrocardiography showed right bundle branch block.

Standard monitoring was commenced, i.v. access established, and an i.v. infusion of Hartmann’s solution started. At this time, an arterial line was not used but would have been sited at any sign of respiratory distress, decrease in oxygen saturation or haemodynamic deterioration. Oxygen was administered through a nasal sponge. A combination of spinal anaesthetic and bi-level positive airway pressure (BiPAP) was chosen for the surgery. A trial of BiPAP was performed to check tolerability and the provision of adequate assisted ventilation. This was then removed while spinal anaesthesia was performed.
At level L2/L4 subarachnoid space, bupivacaine 0.5%, 3 ml with fentanyl 25 µg was injected. This achieved a sensory block with a level at T10. Target-controlled sedation with propofol 0.5 µg ml\(^{-1}\) was commenced followed by the re-initiation of BiPAP. Inspiratory and expiratory positive airway pressures were 16 and 5 cm H\(_2\)O, respectively. She was positioned supine with slight head tilt. BiPAP was maintained throughout the procedure and the intraoperative period was uneventful. After the operation, BiPAP was gradually reduced over a 3 h period while the patient was monitored in recovery. The transition from BiPAP to spontaneous ventilation was very smooth and there were no noticeable adverse effects. Oxygen 2 litre min\(^{-1}\) was administered via a nasal sponge over the next 24 h during which she was monitored in the high dependency unit.

Arterial blood gas analysis after cessation of BiPAP showed pH 7.38, \(P_{aO_2}\) 9.2 kPa (on \(F_{IO_2}\) 0.4), \(P_{aCO_2}\) 5.6 kPa, and HCO\(_3\) 28 mmol litre\(^{-1}\). This was after 1.5 h of BiPAP before and during the operation, and then a further 3 h in recovery. There was a marked decrease in HCO\(_3\) from the preoperative, baseline sample taken on the preceding day and can only be explained by the decrease in \(P_{aCO_2}\), and the use of different blood gas analysers.

The postoperative period was uneventful and pain relief was provided with regular acetylsalicylic acid and codeine phosphate with tramadol, if necessary. She was discharged home 7 days after her operation.

Discussion

The pertinent factors when considering the above case were that the patient was severely obese with a BMI of 37 kg m\(^{-2}\), had advanced COPD, and suffered from cor-pulmonale and pulmonary artery hypertension. Consequently, she had very poor respiratory function tests, her exercise tolerance was 5–10 yards, and she was normally unable to lie flat for more than 10 min.

A common anaesthetic approach to this patient would be to give a general anaesthetic, intubate, and invasively ventilate during and for a period after the operation. However, prolonged endotracheal intubation risks include upper airway trauma, ventilator-associated pneumonia, and compromised speech and swallowing. Instead, we chose to provide spinal anaesthesia combined with NIPPV. Using this technique, we were able to produce satisfactory intraoperative and postoperative analgesia, maintain a supine position for the duration of the operation, and avoid the hazards of general anaesthesia and postoperative ventilation.

By understanding the mechanism by which respiratory compromise, and then failure, occurs in an obese patient with COPD, the rationale for using regional anaesthesia and NIPPV becomes clear.

Ventilation occurs via the combination of the respiratory muscles being able to pump against the load put upon it, and by an adequate central respiratory drive to maintain the pump. Conditions and events which either weaken the pump, increase the workload, or decrease the central drive will increase the risk of an individual developing ventilatory failure. NIPPV has been shown to be effective in the management of a wide spectrum of conditions where there is ventilatory failure secondary to one or more of these factors; for example, because of chest wall deformity, neuromuscular disease, or impaired central respiratory drive. Notably, NIPPV has been increasingly used over recent years in the management of both acute exacerbations and during chronic, stable COPD.

Patients with COPD are particularly prone to ventilatory failure as the disease can precipitate failure by all three of the above factors. This is at least in part a result of the worsening airflow obstruction causing chest hyperinflation, and the development of intrinsic PEEP. Both further increase the workload of the respiratory muscles and increase the likelihood of ventilatory failure. In the postoperative period, the risk of respiratory failure is even greater because of the sedating effects of opiates and anaesthetic agents reducing the respiratory drive.

Our patient was obese with a BMI of 37 kg m\(^{-2}\). In obesity, there is reduction in functional residual capacity (FRC), expiratory reserve volume, and FRC approaches residual volume. Basal lung can become hypoventilated causing a ventilation–perfusion mismatch and arterial hypoxaemia. This is worsened by the compression atelectasis occurring during general anaesthesia whereby lung tissue in dependent regions is compressed by an increased intra-abdominal and pleural pressure. Additionally, there is a cephalad shift of the diaphragm caused by altered chest geometry and diaphragmatic dynamics, and a pooling of central vascular blood into the abdomen. One study has identified a clear reduction in postoperative spirometric volumes related to an increase in BMI and the rate of total body oxygen consumption increasing with weight. Consequentially, obesity predisposes to respiratory failure because of an increased load on a system that already has reduced capacity. This is similar in nature to that occurring in COPD and they probably act synergistically in their generation of respiratory failure.

The NIPPV utilized in this case was bi-level pressure support ventilation referred to as BiPAP. The higher inspiratory positive airway pressure aids ventilation, whereas the lower expiratory positive airway pressure increases extrinsic PEEP, thus counterbalancing any intrinsic PEEP. By doing so, it recruits under-ventilated lung, increasing tidal volume, reducing respiratory frequency, and decreasing the work of breathing. The improvement in ventilation is proportional to the change in pressure applied. This is in comparison with continuous positive airway pressure, which has been shown not to improve ventilatory parameters in the short term, and requires much longer application.

Spinal and epidural anaesthesia are beneficial for both obese and advanced COPD patients. Compared with...
general anaesthesia, the maintenance of spontaneous breathing means there is less cephalad displacement of the diaphragm and less risk of atelectasis. Consequently, closing capacity and FRC are less affected and pulmonary gas exchange is better maintained. However, a recent study has demonstrated a significant reduction in spirometric parameters in the initial period after surgery following spinal anaesthesia in morbidly obese females but still possibly not as great as would have occurred with general anaesthesia. Ideally, we would have used solely nerve block anaesthesia, thus avoiding any respiratory compromise, but the patient’s obesity meant that this was technically not possible.

Other benefits of spinal anaesthesia include superior postoperative analgesia without risking respiratory depression, and avoidance of the strong stimulation of intubation or the risk of bronchoconstriction on extubation. All of these benefits have been reported in the use of combined spinal and epidural anaesthesia for abdominal aortic aneurysm repair in patients with severe COPD.

The disadvantage of using solely regional anaesthesia is that many awake obese and COPD patients are unable to remain in the supine position required for surgery. This was the rationale behind using a combination of spinal anaesthesia with NIPPV.

There are reports of the successful use of postoperative NIPPV in the management or avoidance of acute respiratory failure after corrective spinal surgery, gastropasty in morbidly obese patients, and in patients post-abdominal surgery. Furthermore, NIPPV has been used intraoperatively for awake craniotomy where there was need for smooth transition between anaesthesia and sedation. However, on searching the literature we could find no published cases where NIPPV had been successfully used in the perioperative period for the management of advanced COPD and obesity. Given the pathophysiology of respiratory failure in both of these conditions, the use of NIPPV combined with spinal anaesthesia would appear highly appropriate.

There are complications associated with the use of NIPPV and these include local trauma, gastric distension, eye irritation, sinus congestion, air leaks, and haemodynamic effects. However, the most common problem is usually that of poor patient compliance. This was avoided by a controlled, gradual introduction, checking its tolerability before performing the spinal, and then the use of target-controlled sedation during the operation. Non-invasive ventilation was gradually reduced and then discontinued in the recovery room to avoid sudden changes in the lung mechanics, and thus prevent precipitating respiratory failure. We were aware of the possibility of being unable to perform a spinal because of her obesity, in which case our plan was to revert to a general anaesthetic and postoperative ventilation.

In conclusion, we report the use of a combination of spinal anaesthesia and NIPPV for the insertion of a DHS in an obese patient with advanced COPD, cor-pulmonale, and pulmonary artery hypertension. We would recommend this technique in any patient with advanced lung disease who would otherwise be likely to require postoperative ventilation and who cannot lie flat for the period of surgery.

References