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Non-Intubated Thoracotomy Under an Opioid-Sparing Intravenous Sedation and Analgesia Protocol without Central or Peripheral Nerve Blocks: A Case Report with Insights into Shared Decisions

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Abstract

Key Objectives: Non-intubated thoracic surgery has been performed under regional anaesthesia or sedation. Totally intravenous opioid-sparing analgesia and sedation protocols, without the use of any central or peripheral nerve blocks, have not been used so far for open, non-intubated thoracic surgery. We present the case of a patient who underwent non-intubated thoracotomy under intravenous multimodal opioid-sparing analgesia and sedation. **Methods:** A high-risk patient was referred for non-intubated segmental lung resection. A solely intravenous multimodal opioid-sparing analgesia/sedation strategy was planned, as the patient did not consent to central or peripheral nerve blocks. **Results:** Intraoperatively severe hypoxaemia occurred without signs of tissue hypoxia, which resolved when the lung was re-expanded. There were no other significant events and the patient was later discharged, pain-free and with high level of satisfaction. **Conclusions:** The idea of shared decision-making represents a shift from the basic concept of 'informed consent' to a more deliberative interaction. This involves a robust discussion between the doctor and patient about the best way to shape care in accordance with the patient's values and preferences. In this context an intravenous opioid-sparing strategy, which could prevent the adverse effects of perioperative opioids and regional blocks, could be an efficient alternative in non-intubated thoracic surgery. Intraoperative hypoxaemia is not by default associated with tissue hypoxia and does not always require immediate ventilatory intervention.

Keywords: Thoracic Surgery; Analgesia; Sedation; Hypoxaemia; Hypoxia; Hypercapnia

Introduction

General anaesthesia with endotracheal intubation, the gold standard for thoracic surgery, enables one-lung ventilation (OLV) to improve surgical field [1]. Non-intubated techniques are an alternative approach, as lung collapse by iatrogenic pneumothorax is comparable to the one provided by OLV via a double-lumen tube [1]. Non-intubated thoracic surgery is usually video-assisted (VATS), but it can also be carried out as an open procedure, especially when an initially thoracoscopically planned operation has to be converted into an open one [1,2]. Such operations can be facilitated by regional anaesthesia (thoracic epidural, paravertebral blocks, erector spinae plane block, serratus anterior plane block, intercostal nerve block, or pectoralis nerve block) and sedation, avoiding neuromuscular blockade, endotracheal intubation and positive pressure ventilation [1-5]. Therefore, this approach could be appropriate for high-risk patients, such as the elderly or the ones with cardiac, respiratory or muscular disease [1].

Both regional techniques and intravenous opioids have been associated with adverse effects [6-8]. Current publications on opioid-free and opioid-sparing anaesthesia have increased [9]. Such protocols, based on a combination of agents with different mechanisms of action, inhibiting nociception at different levels [7], have been successfully implemented in thoracic anaesthesia [10,11]. Epidural or paravertebral blocks may be incorporated in thoracic opioid-free protocols [12]. Recently a non-intubated video-assisted pneumonectomy under opioid-free anaesthesia with the concurrent use of both paravertebral and subcostal transversus abdominis blocks was reported [13].

However, to our knowledge, solely intravenous opioid-sparing regimens, without any peripheral nerve blocks, have not been used so far for open, non-intubated thoracic surgery. We report the case of a patient who underwent open, non-intubated thoracotomy under multimodal opioid-sparing analgesia and sedation, without the use of central or peripheral nerve blocks.

Case Presentation

A 70-year-old male patient (weight 69 kg, height 1.68 m) presented for open segmental lung resection due to a solitary pulmonary nodule. Preoperative cardiovascular assessment revealed mild to moderate mitral regurgitation, left ventricle diastolic dysfunction and an ejection fraction of 65%. The patient's main comorbidities included smoking and severe COPD with home oxygen requirement. Spirometry (FEV_1 0.7 L, FVC 0.89 L, both at 34% of their predicted values) raised significant concerns regarding postoperative pulmonary complications and ventilator-weaning difficulty. During preoperative assessment, when informing the patient on possible complications of regional anaesthesia, he did not consent to any regional anaesthetic technique. Therefore, a non-intubated operation under a multimodal opioid sparing analgesic regimen was planned.

Premedication included oral esomeprazole 40 mg and domperidone 10 mg. Before sedation two peripheral venous cannulas and an arterial catheter were inserted. Oxygen (FIO_2 50%) was delivered via a Venturi Mask. Cardiovascular (ECG, blood pressure, heart rate), respiratory (FIO_2, SpO_2, respiratory rate, $ETCO_2$) and sedation (BIS) parameters were monitored.

Sedation was achieved with intravenous midazolam 1 mg, ketamine 20 mg and dexmedetomidine (loading dose 0.5 mcg/kg over 10 minutes and infusion 0.8-1 mcg/kg/h) prior to left decubitus positioning. For optimal intravenous analgesia, a further bolus of ketamine 20 mg was given along with tramadol 100 mg, dexamethasone 16 mg, paracetamol 1g, parecoxib 40 mg and a lidocaine infusion (initial bolus 70 mg and infusion 1 mg/kg/h). Intravenous ondansetron 4 mg and hyoscine 10 mg were administered for their antiemetic and antisialagogue properties respectively. Before surgical incision, the operation site was infiltrated with 70mg of lidocaine (2%) and 150 mg of ropivacaine (0.75%).

Results

Intraoperative sedation lasted for 110 min and the BIS value remained within the range of range of 60-80. Along with dexmedetomidine infusion, subanaesthetic boluses of ketamine 20 mg and propofol 20-30 mg were administered as required. Total doses of dexmedetomidine, propofol and ketamine were 120 mcg, 110 mg and 100 mg respectively. Total dose of intravenous lidocaine was 180 mg. No vasoactive or inotropic support was required intraoperatively. Complete intraoperative amnesia and analgesia were later reported.

Spontaneous ventilation was maintained throughout the operation. A gradual decrease in saturation down to 78% was observed post-pneumothorax without an impact on lactate level or any ECG changes. The total time of hypoxaemic episodes (SpO_2 <90%) was approximately 20 minutes. $PaCO_2$ increased up to 63,2 mmHg, resulting in a blood pH of 7.28. At the end of the operation, the collapsed lung was re-expanded via BiPAP ventilation (IPAP level 20 cmH_2O, EPAP level 10 cm H_2O), resolving hypoxaemia and hypercapnia.

The postoperative course was uneventful. In the post-anaesthesia care unit (PACU) there were no issues regarding arterial blood gases (ABGs), in terms of oxygenation, acid-base balance and lactate. Postoperative pain was managed with regular paracetamol (1 g TDS) and tramadol (100 mg QDS). There were no postoperative complications, and the patient was discharged on the third postoperative day, completely satisfied and pain-free.

Discussion

Post-thoracotomy pain management remains an anaesthetic challenge and is commonly addressed by a thoracic epidural (the gold standard), paravertebral block, or intravenous opioids [6,7,11]. Both regional techniques are associated with significant complications and require patients' consent. Thoracic epidural analgesia may lead to hypotension, epidural haematoma and paradoxical increase in hospital length of stay [6,7]. Paravertebral blocks, although equivalent to thoracic epidural analgesia and with fewer side effects, are still associated with the risk of pneumothorax and haematoma formation [8]. On the other hand, perioperative opioid-based analgesia is related to multiple side effects, such as hypoxia, hypoventilation, retention of secretions, respiratory depression, tolerance and hyperalgesia [7,10,11]. Untreated opioid-induced hyperalgesia contributes to persistent postoperative pain [14]. Even a short remifentanil infusion (0.1 mcg/kg/min for only 30 min) has been reported as sufficient to cause hyperalgesia [14]. Furthermore, the immunomodulatory and immunosuppressive effects of opioids could accentuate lung cancer progression [7,11]. Nevertheless, the use of opioids is very common in non-intubated cases performed under regional techniques or sedation [1]. Sedation usually relies on target-controlled propofol and remifentanil infusions [1].

In our case, patient's refusal to consent to any central or peripheral nerve blocks led us to a balanced multimodal analgesia strategy. An informed consent was obtained after a detailed description of all available anaesthetic strategies and their risks. Emphasis was given to preoperative education of the patient and both physical and psychological preparation. During this education process the patient was encouraged to participate in the formation of the anaesthetic plan, assuring his full cooperation along a non-intubated thoracotomy. The concept of shared decision-making has been prominent in the literature for approximately three decades and a move beyond the basic principle of 'informed consent' to a more deliberative interaction featuring robust discussion between doctor and patient about the best way to shape care in alignment with the latter's values and preferences is supported not only in high-risk but also in low-risk patients [15]. The need for patients to be offered choices and to have their opinion heard is part of a patient's rights and is emphasized as 'Good Medical Practice' for doctors practicing in the United Kingdom [15].

Taking a further step, achievement of a joint decision management pathway among surgeons, anaesthetists and patients remains a real challenge. The preoperative context presents several specific challenges to a fleshed-out and patient-centered decision-making process. One unsurprising obstacle is time, particularly for the anaesthetist, who has very little of it on the morning of surgery. A second difficulty is the position of the anaesthetist within the perioperative pathway. The anaesthetist's thorough evaluation and the patient's comprehension of the potential risks associated with anaesthesia administration are closely connected to the prior decision made by the patient and the surgeon to proceed with the specific surgical procedure. Therefore, the preoperative assessment clinic is the ideal starting point for shared decision-making, and this concept has received widespread support [15]. Our patient was assessed during a single consultation the day before surgery, as there was no preoperative assessment clinic available due to limited resources. Ideally, a series of consultations allowing the patient time to consider and reflect would be more appropriate.

The multifactorial nature of thoracic pain, along with the "opioid epidemic" and opioids' side effects, has prompted a "paradigm shift" in thoracic anaesthesia, incorporating multimodal analgesia and opioid-free anaesthesia protocols [7,10]. Opioid-free anaesthesia may also enhance return to baseline function in thoracic surgery patients [13]. In our case the joint decision pathway resulted in an open, non-intubated lung resection under exclusively intravenous opioid-sparing analgesia and sedation. While thoracotomy is associated with severe pain, the intraoperative sparing of opioids led to the successful management of postoperative pain with the combination of only a mild analgesic and a weak opioid. Furthermore, the antihyperalgesic properties ascribed to some of the agents used (ketamine, lidocaine and non-steroidal inflammatory drugs) [9,16] could contribute in the management of the neuropathic component of pain. Additionally, evidence suggests that providing psychological preparation, including procedural information, sensory information, and behavioural instruction, may benefit postoperative pain outcome [17]. To our knowledge, this is the first reported case of an open, non-intubated lung resection under exclusively intravenous opioid-sparing analgesia and sedation, without any central or peripheral nerve block.

Although recent guidelines emphasize on avoidance of combination of intravenous lidocaine and nerve blocks [16], in our case lidocaine infusion and local anaesthetic infiltration did not have any adverse effect. Lidocaine intravenous doses used (bolus 1 mg/kg and infusion 1 mg/kg/h for 90 min) were significantly lower than the maximum recommended doses (bolus 1.5 mg/kg and infusion 1.5 mg/kg/h for up to 24 h) [16]. Furthermore, low doses of local anaesthetics were infiltrated and the patient had no hepatic or renal pathology.

Titrating sedation for non-intubated thoracic surgery may prove a challenging task. While it should provide anxiolysis and ensure the patient's comfort and cooperation, it also carries the risk of loss of airway patency or respiratory depression, both aggravating hypoxaemia and hypercapnia caused by iatrogenic pneumothorax [1]. We monitored our patient's ABGs under a permissive hypercapnia protocol during spontaneous OLV. Our patient's intraoperative $PaCO_2$ level has been associated with

increased cardiac index and rightward shift in the O_2-dissociation curve during OLV in thoracic anaesthesia [18]. Unfortunately, we did not have a nociception monitor, which could have helped us document antinociception level and further titrate analgesia.

Intraoperatively the patient was hypoxaemic for approximately 20 minutes. In order to address hypoxaemia in non-intubated thoracic surgery, the use of high-flow nasal oxygen therapy has been reported [3]. Unfortunately, at that time we did not have a high-flow oxygen cannula in our department. However, neither the tolerable level of hypoxaemia during OLV, nor the effect of transient intraoperative hypoxaemia on organ function (myocardial, renal, cognition) have been identified [19]. On the other hand, increasing emphasis has been placed upon the potential harm of hyperoxic states, especially for complex patients with comorbidities [19].

It has been reported that oxygen delivery does not directly correlate with peripheral oxygen saturation during OLV, which implies that haemoglobin level and cardiac output are more important factors for avoiding tissue hypoxia [19]. In patients without microcirculation or cellular oxygen uptake abnormalities, tissue oxygen delivery correlates with systemic oxygen delivery (DO_2), which in turn is influenced more by cardiac output than by haemoglobin oxygen saturation (SaO_2) [19,20]. Thus, a high SaO_2 does not by default guarantee adequate DO_2, whereas a low SaO_2 may not jeopardize tissue oxygenation, provided that DO_2 is maintained [20]. Therefore, an urgent need to correct hypoxaemia is not necessarily justified [19]. If DO_2 decreases, oxygen extraction increases to counterbalance oxygen consumption (VO_2) [19]. Tissue hypoxia is expected to occur at a critical level of DO_2: $VO2 < 2$: 1, as oxygen extraction cannot increase any further [19]. Although the tolerable level of hypoxaemia not compromising organ function during OLV has not been identified and may be different in different patients, anaesthesia itself decreases VO_2 [19]. Lactate can be used as a marker of tissue hypoxia [20].

Anaesthetists should tailor the lowest acceptable oxygen saturation level to the specific patient and procedure, taking into account oxygen supply and demand, as well as the consequences of interventions [19]. Rather than aiming for $SaO_2 > 90\%$ in all patients, maybe the SaO_2 target should be considered within the clinical context of haemoglobin level and cardiac output, ensuring that global oxygen delivery corresponds to oxygen demand [19]. Furthermore, in case ventilatory manoeuvres aiming to correct hypoxaemia lead to injury or impair the operation, ensuring adequate cardiac output for oxygen delivery may be a more appropriate intervention [19,21]. Despite the hypoxaemic episode, our patient's lactate never increased, suggesting oxygen delivery was appropriately coupled to his metabolic demands.

The main limitation of this presentation is that it represents a single case, therefore strong conclusions cannot be drawn. Large randomized control trials are required to further clarify the benefit of intravenous opioid-sparing strategies for sedation and analgesia in non-intubated open thoracic surgery.

Conclusions

Opioid-sparing strategies for sedation and analgesia in non-intubated open thoracic surgery are feasible in selected patients. Under such protocols, high-risk thoracic surgery patients, who are good candidates for a non-intubated procedure, may further benefit from the avoidance of opioids' respiratory adverse effects or the possible haemodynamic compromise associated with thoracic epidural analgesia.

In this context, it is crucial to highlight the value of a shared decision pathway involving surgeons, anaesthetists and patients. Emphasizing shared decision-making as a central component of delivering high-quality, truly patient-centered perioperative care, despite current challenges, is essential. The literature, the law, and healthcare policy all confirm that shared decision-making is what patients truly desire. It transcends mere informed consent and information transfer necessitating education on our non-technical proficiencies.

As for intraoperative hypoxaemia, it is not by default associated with tissue hypoxia and studies examining the tolerable level of hypoxaemia during one-lung ventilation in humans or the consequence of transient intraoperative hypoxaemia on outcomes, such as surgical infection, renal insufficiency, myocardial dysfunction, or postoperative cognitive dysfunction, are required.

Ethical Considerations: Informed consent to publication was obtained from the patient.

Conflicts of Interest: The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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