

Feasibility of THRIVE oxygenation and intra-operative lung-protective ventilation in morbidly obese patients undergoing neurosurgical procedures

ABSTRACT

The conduct of anesthesia in morbidly obese patients undergoing neurosurgical procedures can be challenging considering the multi-system organ involvement. Implementation of conventional lung-protective ventilation in morbidly obese patients can have a negative impact on the intra-cranial dynamics. We report a series of three patients with morbid obesity and a difficult airway for the neurosurgical procedure. The patients were oxygenated with high-flow oxygen devices to ensure an adequate oxygen reserve in the peri-operative period. A modified intra-operative lung-protective ventilation with normocarbia was implemented with no impact on the intra-cranial pressure in the prone position in two of the patients. Oxygenation with high-flow devices should be considered during the peri-operative period in morbidly obese patients to avert an adverse respiratory event, and a modified lung-protective ventilation technique is feasible with normal intra-cranial dynamics intra-operatively.

Key words: Anesthesia, lung-protective ventilation, morbid obesity, neurosurgery, prone position, THRIVE

Introduction

Morbid obesity is defined as a body mass index (BMI) of $>40 \text{ kg/m}^2$ without an associated medical comorbidity or BMI $>35 \text{ kg/m}^2$ with significant comorbidities.^[1] Obesity poses many challenges in the peri-operative period because of multi-system organ involvement. Issues related to airway, ventilation, and oxygenation gain special attention from the anesthesiologists' perspective. Maintaining oxygenation during anesthesia induction and post-extubation in the morbidly obese patients is also crucial and challenging. Implementing a conventional lung-protective ventilation

strategy in the intra-operative period is challenging in neurosurgical patients with raised intra-cranial pressure and poor cerebral compliance. Prone position surgery forms an integral part of the neurosurgical procedures, and prone ventilation can be challenging in morbidly obese patients. We report a series of three morbid obese neurosurgical patients with an emphasis on the mask-free Trans-nasal Humidified Rapid Insufflation Ventilatory Exchange (THRIVE) (Optiflow®, Fisher & Paykel Healthcare Limited, Auckland, New Zealand) oxygenation in the peri-operative period and feasibility of

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modified lung-protective ventilation in the prone position without a significant impact on the intra-cranial dynamics.

Case Report

Case 1

A 45-year-old male patient diagnosed with ossified ligamentum flavum (OLF) of the cervical spine was posted for decompressive laminectomy in the prone position. The patient had no comorbidity, and sensorimotor deficits were noted on clinical examination in the distal extremities of the upper limbs. His anthropometry revealed a height of 160 cm and a weight of 148 Kg with a calculated BMI of 57.8 kg/m² (ideal body weight: 57 kg). The patient had features of a difficult airway that included an excessive sub-mandibular pad of fat, a thyromental distance of two fingerbreadths, and Mallampatti of class 3. Anticipating an airway event, a rapid sequence induction with THRIVE was performed. The patient was pre-oxygenated with THRIVE using a flow of 30 L/min for 3 minutes. The THRIVE flow was escalated to 70 L/min following the administration of 350 mg of intravenous thiopentone and 100 mg of intravenous rocuronium. After a minute (apnoeic period), the patient was intubated using a video laryngoscope with ongoing THRIVE oxygenation. Arterial saturation remained above 97% during the apneic phase. With the first ventilation after intubation, EtCO₂ showed a value of 36 mmHg, suggesting no CO₂ accumulation. The patient was then turned prone, all the pressure points were adequately protected, and free-hanging of the abdomen was ensured. The lungs were ventilated with an 8 ml/kg (IBW) tidal volume in a volume control mode with the positive end expiratory pressure (PEEP) set at 7 cm H₂O. Normocapnia (EtCO₂ 35–40 mmHg) was maintained intraoperatively by adjusting the respiratory rate between 25–30 breaths/min. The airway plateau pressure and driving pressures remained between 25 and 28 cm H₂O and between 18 and 21 cm H₂O, respectively. Following an uneventful course, the trachea was extubated. The post-extubation oxygenation was provided with THRIVE in the post-anaesthesia care unit (PACU) for 15 minutes and later to Hudson's face mask with an oxygen flow of 3 L/min.

Case 2

A 30-year-old female was posted for craniotomy and decompression of the tentorial meningioma. The patient had a height, weight, and BMI of 161 cm, 140 kg, and 54.7 kg/m² (IBW 53 Kg), respectively, and a Mallampatti of class 3 on airway examination. The patient was oxygenated in a ramp position with a THRIVE flow of 30 L/min for 3 minutes, following which anesthesia was induced with 150 mg of intravenous propofol and 150 mg of intravenous succinylcholine. The trachea was intubated successfully using a video laryngoscope with

concomitant THRIVE insufflation. With the first ventilation after intubation, EtCO₂ showed a value of 35 mmHg. The lung was ventilated in the prone position with the pressure control ventilatory mode to target a tidal volume of 6–8 ml/kg of the IBW and a plateau pressure of 26–28 cm H₂O. Normocapnia was maintained throughout the intra-operative period by adjusting the respiratory rate between 25 and 30 breaths/min. The driving pressure was maintained between 18 and 20 cm H₂O with a PEEP of 8 cm H₂O. No brain bulge was noticed after the craniotomy. The trachea was extubated on the table after an uneventful surgery lasting 12 hours, and overnight oxygen support was provided with THRIVE (flow 35L/min, FiO₂ 0.4) without any complication.

Case 3

A 60-year-old male diagnosed with left frontoparietal glioma was scheduled for craniotomy and tumor decompression in the supine position. Anthropometry revealed a height of 170 cm, a weight of 120 kg, and a calculated BMI of 41.7 Kg/m² (IBW 66 kg). Rapid sequence induction with THRIVE was performed in a ramp position with intravenous propofol of 150 mg and intravenous succinylcholine of 100 mg. The trachea was intubated successfully with a video laryngoscope. Normocapnia was maintained with a tidal volume of 6–8 ml/kg IBW with pressure control ventilation and a 24–28 breaths/min respiratory rate with intra-operative plateau pressures of 24–28 cm H₂O. The driving pressures remained between 16 and 20 cm H₂O with a PEEP of 8 cm H₂O. Post-extubation respiratory support was provided with THRIVE for 2 hours.

Discussion

In obese patients, the functional residual capacity drops significantly, increasing the alveolar-arterial oxygen pressure gradient. There is also a higher incidence of obstructive sleep apnea (OSA) in obese patients.^[2] All these factors contribute to a decreased respiratory reserve and an increased risk of peri-operative respiratory events in morbidly obese patients. The presence of difficult airways also mandates the practice of rapid sequence induction in these population groups. The pre-oxygenation with the conventional mask devices cannot meet the higher peak inspiratory flow demands of the morbidly obese patients. THRIVE is an excellent tool that safely maintains oxygenation during the performance of rapid sequence induction by providing a humidified high flow oxygen of 70 L/min. Pulmonary atelectasis is conducive during general anesthesia, which mandates the application of the alveolar recruitment maneuver (ARM) before extubating the trachea. However, the beneficence of ARM is short, and obese patients tend to develop respiratory complications in the post-anesthesia care unit (PACU). High-risk patients can be

extubated with THRIVE, and the provision of THRIVE flows can prevent post-operative pulmonary complications. THRIVE can provide a positive airway pressure of 1 cm H₂O for every 10 L of gas insufflated.^[3,4] The provision of dynamic, positive airway pressure prevents post-operative pulmonary complications, especially following the tracheal extubation in the PACU.

Ventilating the morbidly obese patients in a prone neurosurgical procedure carries few concerns. Ventilation with a high tidal volume could lead to barotrauma in obese patients because of decreased respiratory system compliance. Lung-protective ventilation with a tidal volume of 6–8 ml/kg IBW and an individualized PEEP in the intra-operative period is recommended.^[5] A plateau pressure of less than 30 cm H₂O is crucial to prevent barotrauma.^[6] On the contrary, the permissive hypercapnia during lung-protective ventilation can have a detrimental effect on the intra-cranial dynamics. Unlike in the intensive care unit, the brain condition following the lung-protective ventilation strategy can be directly observed after craniotomy. These patients can be ventilated with a fixed tidal volume of 6–8 ml/kg of IBW, and normocapnia can be achieved by adjusting the respiratory rate. The two patients in this series did not develop brain bulge intra-operatively, indicating that the lung-protective ventilation in this patient group is feasible.

To conclude, THRIVE oxygenation in morbidly obese patients should be an integral part of the armamentarium in the peri-operative period and lung-protective ventilation without a negative impact on intra-cranial dynamics is feasible in morbidly obese patients undergoing neurosurgical procedures even in the prone position.

Declaration of patient consent

The authors certify that they have obtained all appropriate patient consent forms. In the form, the patient(s) has/have given his/her consent for his/her images and other clinical information to be reported in the journal. The patients understand that their names and initials will not be published and due efforts will be made to conceal their identity, but anonymity cannot be guaranteed.

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Conflicts of interest

There are no conflicts of interest.

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