Prevention of the formation of atelectasis during the induction phase in a general anesthesia by the use of high-flow nasal cannulas in the obese patient.

Primary Author: andrea gutierrez specialist in anesthesiology and critical care clinic university hospital valencia

Co-Authors: carlos ferrando, ; esther romero, ; ferran serralta, resident; jaume puig, ; javier belda, head of department; juan carrizo, resident; marina soro, ;

Background and goal of study

The most frequent post-operative complication after general anesthesia is hypoxemia, mainly due to the onset of atelectasis. General anesthesia involves the formation of atelectasis, and these occur mainly during induction and the first few minutes of mechanical ventilation (MV). The lack of prevention and opening these atelectasis during MV make them to persist during postoperative period. It can be added new atelectasis in the immediate postoperative period to the atelectasis produced during the intraoperative period due to hypoventilation generated by the residual effects of general anesthesia. The presence of atelectasis in the postoperative period increases the incidence of postoperative pulmonary complications (PPC). The occurrence of PPCs increases MV days in the post-operative period and non-scheduled re-admissions, as well as the days of stay in the intensive care units. In patients with morbid obesity, more atelectasis appear in comparison with non-obese during general anesthesia. In addition, hours after the end of the surgical procedure, atelectasis persists in morbid obese patients, while in the majority of non-obese patients they disappear completely. The application of a positive pressure during the induction period has shown a decrease in the presence of atelectasis and therefore of PPC. Several studies have described the high-flow nasal cannula (HFNC) as an alternative for the application of positive pressure in the airway. It consists of an air-oxygen mixer with adjustable FiO2 that provides a humidified and hot modifiable gas flow. This hyperflow of gas generates a certain level of continuous positive airway pressure. Comparing the use of conventional CPAP with the oronasal or holofacial interface, the HFNC, in addition to a greater comfort, have the advantage of maintaining pressurization throughout the entire process of anesthetic induction, allowing the laryngoscopy to be performed, as well as during extubation. With conventional CPAP it is impossible to maintain this pressurization, and patient collaboration is reduced because of the sensation of a pressurized mask.

Until recently, the diagnosis of atelectasis required imaging techniques such as chest x-ray or tomography. Tomography is considered the gold standard. The chest X-ray, although it is the most commonly used imaging technique at bedside, has shown a low sensitivity and specificity for the diagnosis of atelectasis and poor correlation with tomography. Currently it is possible to detect the presence of atelectasis by a non-invasive method, the Air Test, which consists of breathing oxygen for 5 minutes with FiO2 0.21 and if the oxygen saturation (SpO2) by pulse oximetry is ≥97% the presence of atelectasis is discarded. The first clinical manifestation of atelectasis is hypoxemia, to manifest clinically the percentage of intrapulmonary bypass caused by atelectasis should be greater than 10% when breathing ambient air (FiO2 0.21). When this shunt causes a drop in blood
oxygen pressure (PaO2), this decrease leads to a decrease in the peripheral SpO2. Taking as reference the behavior of the curve of dissociation of hemoglobin in normal lung, a cutoff point of an SpO2 ≤ 97% with a FiO2 of 0.21 an open lung condition (absence of atelectasis) is defined. Therefore, SpO2 ≤ 96% at a FiO2 of 0.21 would diagnose the presence of atelectasis. This method has recently been validated using reference techniques for the diagnosis of atelectasis.

Monitoring patient’s oxygen status is essential during the perioperative period. Currently, a parameter called Oxygen Reserve Index (ORI) is available, which is a relative indicator of the blood PaO2 in the range of 100 to 200 mmHg; this parameter allows continuous detection of periods of moderate hypoxemia and so on warns about an imminent real hypoxia.

As discussed above, pulmonary atelectasis courses with hypoxemia, but these are masked when supplemental oxygen is administered, otherwise it is necessary for the anesthetic induction. So, a decrease of the ORI level maintaining the same FiO2, could detect the formation of atelectasis early before hypoxemia appear.

According to the data available derived from the use of the ORI parameter, a drop of its value equal to or greater than 50% with the same FiO2, could be considered significant of a drop in the value of PaO2 sufficient to justify a shunt effect, in this context with high probability due to the effect of new atelectasis.

For all this, the realization of a clinical study is justified during the induction and immediate postoperative period in morbidly obese patients submitted to general anesthesia with risk of atelectasis such as obese patients undergoing abdominal surgery, that validates the use of HFNC as a method of prevention of atelectasis both in the induction and the eduction phase, valued through new techniques of determination such as ORI and the Air Test, and as a method to optimize perioperative oxygenation.

Hypothesis:

Placement of high-flow nasal cannulas during the induction process and eduction, as well as immediate postoperative period, in general anesthesia of the obese patient reduces the formation of atelectasis.

Methodology:

Randomized prospective.

Study protocol:

Intraoperative and postoperative anesthetic, hemodynamic, respiratory and analgesic management will be performed according to usual clinical practice, following the protocols of anesthetic management of the Anesthesiology and Critical Care department, being the same for all the patients.

Two possible groups to assign:

A) Group with HFNC:
Prior to initiation of induction, during preoxygenation, the HFNC will be used through the Precision Flow device (Vapotherm, UK). The gas flow will be adjusted to 50 L/min, whereby the pressure generated would be equal to 6 cmH2O, and FiO2 0.5 for 10 minutes. SpO2 and ORI will be recorded for 1 minute before starting pre-oxygenation and during 10 minutes of pre-oxygenation. After that, the anesthetic induction will proceed in the usual way and under the criteria of the anesthesiologist in charge, without withdrawing the HFNC until the intubation and the connection to the anesthetic machine have been made in automatic mode, previously configured with a minimum pressure value in the airway of 10 cmH2O and FiO 2.0.5. After 5 minutes, an alveolar recruitment maneuver (ARM) will be performed following the technique of Open Lung Approach, adjusting PEEP level to the appropriate value after performing the maneuver. Previously to the performance of the ARM must be ensured adequate hemodynamic stability (mean arterial pressure (MAP) > 70 mmHg and/or cardiac index > 2.5 L/min/m2), systolic volume variation or pulse pressure < 10% for at least 5 minutes prior to the maneuver, and an adequate neuromuscular relaxation.

The rest of the intraoperative ventilatory management will be done according to the criteria of the anesthesiologist in charge. Arterial blood gases and ORI value records will be performed serially as described below. Extubation will be performed with the HFNC at 50 L/min with FiO2 0.5, maintained throughout the transfer process, in order to maintain the pressurization continuously.

Once the patient arrives at the PACU, oxygen therapy with HFNC at 50 L/min and FiO2 0.5, with continuous recording of SpO2 and ORI. After 30 minutes after admission to the PACU, when the patient is collaborative, with an acceptable neurological status, the HFNC will be withdrawn and oxygenate the patient with a FiO2 of 0.21 for 5 minutes. If SpO2 ≤ 96%, atelectasis will be diagnosed. If SpO2 ≥ 97%, no atelectasis will be diagnosed. If SpO2 ≤ 96%, atelectasis will be diagnosed. If SpO2 ≥ 97%, no atelectasis will be diagnosed. If SpO2 ≤ 96%, atelectasis will be diagnosed. If SpO2 ≥ 97%, no atelectasis will be diagnosed.

Venturi mask will be placed with FiO2 0.5 and management according to the criteria of the PACU manager. Air-Test will be performed during first 2 hours of stay in PACU.

B) Group without HFNC:

The same techniques and procedures will be performed as in the other group, but without placing HFNC. Oxygenation during induction and eduction will be performed with a Venturi mask 15 L/min.

Study variables:

They will be grouped as follows:

Demographic/Pharmacological/Gas exchange variables and other values of the arterial blood gases/Ventilator variables/ORI and SpO2; Will be collected from the hemodynamic monitor Radical-7 Pulse COOximeter in Root® (Masimo, Irvine, CA, USA).

Chest X-ray at 24 hours after surgery, with SpO2 determination.

Sampling times of the variables:

T1: One minute prior to the placement of the HFNC: ORI and SpO2 value will be recorded. T2: After 10 minutes placing the HFNC and after having performed preoxygenation. T3: After performing ETI, prior to the ARM. T4: After 5 minutes of having performed the ARM. T5: Prior to extubation. T6: When
admission at the PACU.

T7: After 30 minutes of stay in PACU.

T8: After 60 minutes of stay in PACU.

T9: After 90 minutes of stay in PACU.

T10: After 120 minutes of stay in PACU.

T11: After 24 hours a chest x-ray will be performed to assess the presence of atelectasis.

Results and discussion:

With the patients collected, observing most important values, SpO2 and PaO2, comparing the groups we can see both values are higher in the group receiving HFNC during induction period compared with the control group (graphs attached). With no differences in demographic, pharmacological and ventilator variables. According to the Air Test, in T7 (after 30 minutes in PACU) it was positive in 3 of 16 patients of HFNC group, and was positive in 10 of 16 in control group. Regarding the 24-hour chest X-Ray after surgery, it showed existence of atelectasis in 4 of 16 patients in HFNC group, and 11 of 16 patients in control group. Which suggest that the use of HFNC could be good to prevent atelectasis in this group of patients.

With the results obtained, we can conclude that the use of HFNC in the preoxigenation period during the induction and also during the eduction period of a general anesthesia in obese patients undergoing an abdominal surgery could be useful to avoid the appearance of atelectasis in the preoperative period.