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Optimal Positioning of Critically Ill Obese Patients

In endotracheally intubated, mechanically ventilated obese patients, head-up positions seem not to be as effective as in extubated, spontaneously breathing obese ones. Sprung et al. (2003) reported that although initial arterial oxygenation was worse in patients with massive obesity when compared with normal-weight patients, gas exchange remained almost constant regardless of mode of ventilation or body posture (supine vs. Trendelenburg's position vs. reverse Trendelenburg's position). However, the limitation of their study is the very short equilibration intervals of only five minutes.care of obese and morbidly obese patients is a major challenge because the patients present a wide spectrum of pre-existent pathophysiological disorders that may interfere with treatment (see p.12). Especially respiratory and cardiovascular limitations are reasons for complications and a prolonged duration of intensive care unit (ICU) stay in obese patients. Can such a simple thing as optimal positioning help to improve the wellbeing of the patient, reduce complications and, ultimatively, improve outcome?

Optimal positioning of an obese patient in intensive care has to fulfil several conditions:

1. Preventing harm to the patient;
2. Physical well-being of the patient;
3. Relief of ventilation and cardiac function;
4. Postoperative pulmonary and cardiocirculatory stabilisation, and
5. Facilitation of clinical procedures, e.g. weaning from mechanical ventilation.

Positional manoeuvres can impose extreme stress on obese patients and are often accompanied by significant changes of pulmonary and cardiocirculatory parameters. Specifically, severely obese patients tolerate relocation badly, so that any positional change has to be considered well and performed with maximal caution. Figure 1 gives an overview on the different positions used in intensive care.

This narrative review outlines the pathophysiology and specific complications associated with the positioning of obese patients. Understanding of these principles should allow safer intensive care treatment of this unique patient collective.

Supine Position

Supine positions are dangerous for patients with higher grades of obesity and should be avoided. Tsueda et al. described the "supine obesity death syndrome": A 38-year-old patient with a Body Mass Index (BMI) of 84 kg/m2 became dyspnoeic after lying down supine for a radiological procedure. Consecutively, he developed respiratory and cardiocirculatory arrest and died after unsuccessful resuscitation.

But even in patients with lower grades of obesity, supine positioning can be harmful. Changing awake, spontaneously breathing obese patients from sitting to the supine position results in increased oxygen consumption and elevated cardiac output.

Abdominal surgery in morbidly obese patients is often followed by respiratory dysfunction (Pelosi et al. 1999). Nine patients with a BMI of 51 ± 8.2 kg/m2 were postoperatively studied in the ICU. The patients were mechanically ventilated and lying in the supine position. Gas exchange in obese patients was worse when compared with normal-weight patients (PaO2 110 ± 30 mmHg vs. 218 ± 47 mmHg at FiO2 = 0.5). A PEEP of 10 mmHg cmH20 could improve respiratory parameters of the obese patients significantly, while PEEP was not effective in the normal-weight control group.

Trendelenburg's Position

Trendelenburg's position is extremely harmful for patients with massive obesity. This position compromises the respiratory and cardiovascular system by auto-transfusion of blood to the heart and compression of the lung by abdominal fat-masses. Awake, spontaneously breathing obese patients should never be moved into Trendelenburg's position, e.g. for intensive care manoeuvres like the insertion of a central venous catheter. Hypoxaemia and cardiac decompensation may follow and threaten the patients' lives. Clinical studies in endotracheally intubated, mechanically ventilated obese patients demonstrated significant decreases in arterial oxygenation after Trendelenburg's position had been established (Meininger et al. 2006).

Head-Up Positions

Elevating the upper part of the body relieves the diaphragm from the weight of intra-abdominal contents and abdominal fat-masses and eases ventilation in obese patients. Suitable positions are:
1. Semi-recumbent position;
2. Reverse Trendelenburg's position;
3. Beach chair position, and
4. Cardiac chair position.

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Particularly postoperatively, obese patients are at high risk for pulmonary complications and hypoxaemia. Vaughan and Wise studied 22 female patients with a mean BMI of 49 kg/m2 and reported that during the first 48 hours after abdominal surgery gas exchange significantly improved with change from the supine to the semi-recumbent posture. For obese patients, specifically morbidly obese patients, it is recommended to establish a head-up position directly after end of anaesthesia and for endotracheal extubation. This posture should be maintained during transport from the operating room to the ICU, where it is continued for the duration of the recovery. For safe transport and intensive care of morbidly obese patients, special hospital beds to accommodate patients of > 200 kg of body weight are mandatory (Brodsky et al. 2002).

In endotracheally intubated, mechanically ventilated obese patients, head-up positions seem not to be as effective as in extubated, spontaneously breathing obese ones. Sprung et al. (2003) reported that although initial arterial oxygenation was worse in patients with massive obesity when compared with normal-weight patients, gas exchange remained almost constant regardless of mode of ventilation or body posture (supine vs. Trendelenburg's position vs. reverse Trendelenburg's position). However, the limitation of their study is the very short equilibration intervals of only five minutes.

Weaning

Weaning from mechanical ventilation benefits from head-up positioning of the obese patient. Burns et al. (1994) studied the weaning of 19 patients with large abdomens either due to obesity, ab - dominal distension, or ascites in different head-up positions. The 45° reverse Trendelenburg's position was identified as ideal for weaning trials because this posture lead to a significantly increased tidal volume (VT) and lower respiratory rate (RR). This form of positioning was even superior to sitting and semi-recumbent bedding.

Beach Chair Position

Positioning an obese patient in the beach chair position is a relatively new concept. Valenza et al. (2007) investigated 20 endotracheally intubated and mechanically ventilated obese patients with a BMI of 42 ± 5 kg/m2. They moved the patients from supine to beach chair position and could demonstrate that the latter posture increased lung volumes, improved oxygenation and respiratory mechanics. The effect was in the same order of magnitude as the application of 10 cmH2O PEEP. Studies in awake, spontaneously breathing obese patients, however, are still lacking.

Cardiac Chair Position

The cardiac chair position is often applied in obese patients suffering from cardiac insufficiency or dyspnoea. From the pathophysiological viewpoint, the lungs are relieved from abdominal pressure and the heart is disburdened from venous preload. Up to now, however, there exists no clinical study that has investigated this posture in obese patients.
Patients with obesity, especially those with higher grades of obesity, benefit from head-up positions. Regular cardiopulmonary monitoring - even in head up positions - is highly recommended.

Lateral Decubitus Position

Obese patients are often placed in the lateral decubitus position for prophylaxis of pressure ulcers. But also pulmonary parameters may benefit from the lateral posture as the abdomen is relieved from the weight of the panniculus, which probably reduces intra-abdominal pressure and enhances dia phragm motility.

A clinical study in obese subjects (BMI 44 ± 5 kg/m2) revealed, however, that VT and RR did not change when subjects were moved from sitting to supine or lateral (Pankow et al. 1998). This is different in normal-weight subjects: Lowest VTs can be observed in the lateral position. The same study investigated the level of intrinsic PEEP (PEEPi) that must be overcome during each inspiration and is a surrogate parameter for work of breathing. PEEPi decreased in obese subjects significantly when they changed from supine to lateral position. These results support the view that lateral posture is advantageous for obese patients when compared with supine posture.

Complications

In the lateral decubitus position, lower lung volumes of the dependent lung can be observed in obese subjects. This can lead to hypoxaemia, lung oedema and atelectasis of the dependent lung. Periodical alternation of lateral posture and regular cardiopulmonary monitoring should be arranged, especially in morbid obesity.

Attention should also be paid to epidural catheters. The higher the BMI the more probable is catheter movement associated with a change in the patient's position. Dislocations of up to 4.3 cm were observed (Hamilton et al. 1997).

Prone Position

Prone positioning is used in endotracheally intubated and mechanically ventilated patients with acute lung injury (ALI) and acute respiratory distress syndrome (ARDS) to treat severe, life-threatening hypoxaemia. Increases of 52 ± 59 mmHg in PaO2 / FiO2 could be observed in normal-weight patients with ALI or ARDS (Protti et al. 2009).

In obese patients, however, it was believed that prone positioning was harmful and should be avoided whenever possible. A study in 10 endotracheally intubated and mechanically ventilated obese patients (BMI 34.6 ± 4.8 kg/m2) reported that prone position compared with supine posture positively affected respiratory mechanics, significantly improved oxygenation (PaO2 of 130 ± 31 mmHg vs. 181 ± 28 mmHg at FiO2=0.4) and enhanced functional residual capacity (FRC) (894 ± 327 ml vs. 1980 ± 856 ml) (Pelosi et al. 1996). The study demonstrates that mechanical ventilation in prone position is safe also in obese patients and improves pulmonary function. This posture could possibly be a promising option in the intensive care of obese patients with ALI or ARDS suffering from severe hypoxaemia. It is, however, important that prone position is correctly executed and free abdominal movement is guaranteed. Contraindications of prone position such as acute central nervous system injury, instable cardiocirculatory situation, and an unstable spinal column have to be kept in mind.

Rotational Bed Therapy

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Positioning therapy in rotating beds is assumed to improve drainage of secretions of the airways and to counteract atelectasis and consolidation of dependent lung regions. Additionally, this form of positioning should prevent several hazards of immobility, such as pressure ulcers, deep vein thrombosis, constipation, muscle atrophy, etc.

A meta-analysis of 16 prospective randomised studies on rotational therapy was performed and indicated that the incidence of pneumonia was lower when the patients were positioned in rotational beds compared with manual turning of patients by nurses every two hours. However, no effect on duration of mechanical ventilation, number of ICU days or hospital mortality could be observed (Goldhill et al. 2007). Little evidence is available regarding the most effective rotation parameters as degree of rotation and time intervals, which may vary with the underlying disease and the weight of the patient. From pathophysiologic considerations, patients with higher BMI may benefit more than others because this patient collective is more likely to develop respiratory complications. Obese patients may also profit from rotational beds because they possibly receive more turning intervals as by manual turning which requires sufficient manpower and the coordination of many people. However, studies in obese patients are lacking.

Summary

Positioning considerations are extremely important for the treatment of obese patients in the ICU. These patients can experience serious physiologic impairment if improperly positioned. Trendelenburg's position and supine position put the obese patients at risk for developing severe respiratory insufficiency and cardiocirculatory complications and should be avoided whenever possible. Knowledge on optimal positioning of critically ill obese patients is essential as the incidence of obese and morbidly obese patients in our ICUs is rising.

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