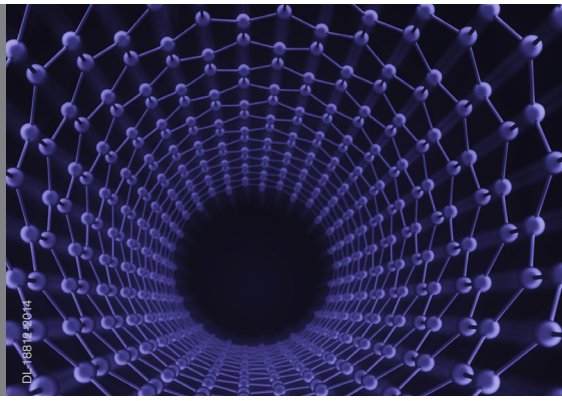
Technology Insights

for the ventilation of obese patients undergoing general anaesthesia

Protective ventilation in the OR poses major requirements to anaesthesia workstations. Dräger works closely with clinicians and nursing staff around the world to understand the precise needs and requirements for protective ventilation in the OR.

Below we describe the latest ventilation technologies in our anaesthesia workstations enabling successful protective ventilation strategies.



INTRODUCTION

Anaesthetists and anaesthesia nurses face special challenges when managing obese patients. These challenges will become more frequent in the future because the number of obese patients is rising steadily all over the world. In order to provide the best care for obese patients, it is important that the technology used, supports the recommended clinical procedures and approaches in the best possible way. Below we describe some relevant special characteristics of obese patients and explain the general technical conditions that an anaesthesia workplace should fulfil to ensure the best patient care.

RELEVANT CHARACTERISTICS OF OBESE PATIENTS

The special characteristics of obese patients described below are set out in detail, with references, in our clinical whitepapers on the pre-oxygenation and induction of obese patients (click here) and the intraoperative ventilation of obese patients (click here).

DIFFICULT INTUBATION

Obesity, and in particular morbid obesity, is often associated with difficult intubation. Sufficient time should therefore be allowed for the intubation of these patients, and the patient's oxygen reserves should be filled up in advance to prevent the oxygen saturation from decreasing.

INCREASED WORK OF BREATHING

Some obese patients have markedly increased work of breathing. The main factors responsible for this are the abdominal mass, which presses against the diaphragm in the cranial direction in particular when the patient is supine, thus restricting the diaphragms movement, and the restricted extension of the thorax owing to the greatly increased amount of fatty tissue. Both of these factors exert adverse effects in particular when the patient is supine and make spontaneous breathing as well as mechanical ventilation more difficult for obese patients. Therefore, assisting the patient in spontaneous breathing is a very important task of modern anaesthesia ventilators. Already during pre-oxygenation the assistance in spontaneous breathing is crucial in order to ensure sufficient oxygen reserves for intubation and the associated apnoea phase. Furthermore, intraoperative manoeuvres, such as recruitment manoeuvres need to be supported, either by dedicated functionalities automising the procedure, or by easy manual setting of respective parameters. Recruitment manoeuvres should be combined with dedicated tools visualising the success of recruitment manoeuvres and allowing to observe the haemodynamic status along the procedure.

ATELECTASIS

The risk of atelectasis also rises with increasing obesity. Morbidly obese patients may exhibit clinically relevant atelectases even when upright. This may aggravate when the patient is supine. The commonly applied mechanical ventilation encourages the further spread of atelectatic areas of the lungs if not adjusted to the needs of obese patients. Already during induction of general anaesthesia, the course can be set for the intraoperative and even for the postoperative phase, in order to reduce the risk of complications. But also in the course of intraoperative ventilation, e.g. recruitment manoeuvres plus an adequate PEEP may play an important role in reducing atelectasis, maximising FRC and mitigating the risk for postoperative pulmonary complications.

INTRINSIC PEEP (PEEPi)

Intrinsic PEEP is frequently a direct consequence of obesity. The constrictions in the airways which are often found in obese patients increase airway resistance. Coupled with a possibly shortened expiration time, this results in incomplete expiration and thus in a residual pressure in the lung. This residual pressure represents a resistance that initially has to be overcome at the onset of inspiration before an inspiratory flow can be achieved. This should be taken into account especially during pre-oxygenation, to ensure adequate oxygen saturation in the lung. But also postoperatively, when the patient is extubated, this may lead to impaired spontaneous breathing.

Below we describe some technical solutions that can support you during pre-oxygenation and intraoperative ventilation, in particular when treating obese patients.

TECHNOLOGY SUPPORTING ANAESTHETIC MANAGEMENT OF OBESE PATIENTS

Active CPAP

In order to actively counteract the intrinsic PEEP of obese patients during pre-oxygenation, the anaesthesia machine should be capable of applying an active CPAP during induction. A real CPAP supports the patient with a continuous flow that actively counteracts the intrinsic PEEP and thus reduces the work of breathing. In the absence of a real CPAP, attempts are often made in Man./Spont. Mode to simulate a CPAP by setting an APL valve to the desired pressure. However, it is important to understand, that the pressure set for the APL valve acts primarily as a resistance instead of providing active support. This means that the APL valve does not reduce the work of breathing but merely makes expiration more difficult. Furthermore, spontaneous breaths of the patient typically create a pressure drop. These pressure drops can only be avoided by the fast flow delivery of a modern ventilator (active CPAP) which can deliver a multiple of the gas flow which is settable for the fresh gas flow*.

Spontaneous breathing without CPAP

Spontaneous breathing with activated CPAP

The Dräger ventilation units TurboVent 2 (installed in the Dräger anaesthesia machines Zeus® IE and Perseus® A500) have a blower ventilator that can deliver an active CPAP without any interruptions. The blower delivers a continuous circle flow, thus enabling the rapid mixing of gases in the breathing circuit and with it rapid changes in gas concentrations. The blower can adjust its speed extremely rapidly, thus reacting to pressure changes during spontaneous breathing and maintaining a constant pressure at the level set. The E-Vent plus piston-based ventilator installed in the Primus® family is capable of applying a real, active CPAP via the Pressure Support mode. In Pressure Support mode the pressure support is reduced to 0 mbar. If you would like to know more about Dräger ventilator technologies please click here.

Pressure Support + CPAP

Pure CPAP may be a great help for moderately obese patients, given that it can facilitate independent spontaneous breathing in the supine position. However in cases of advanced obesity this may not be sufficient, rendering it necessary to support breaths in order to achieve near normal tidal volumes. The very high trigger sensitivity, which can be adjusted to the individual patient, coupled with the fast reactions of the electronic ventilators E-Vent/ plus and especially TurboVent 2, ensure rapid and synchronous pressure support for spontaneous breathing. The rate at which the pressure rises can be adapted using slope adjustment to take account of the individual lung mechanics. During the expiration phases the PEEP (CPAP)

*) E.g. Perseus A500 has a maximum FG flow of 15 L/min and a maximum ventilator flow delivery of 180 L/min.

is maintained appropriately. This function is available with all Dräger Primus, Perseus and Zeus anaesthesia machines. Synchronisation and reaction times of Dräger's current ventilator technologies, especially the TurboVent 2 blower, correspond to the performance of modern intensive care ventilators.

Reducing the resistance in the breathing circuit.
In the blower-driven anaesthesia machines, the circular flow reduces the resistances arising due to the breathing system in order to additionally facilitate spontaneous breathing at the PEEP (CPAP) level and thus to reduce the required work of breathing. During expiration, the E-Vent plus piston-driven ventilators synchronise themselves with the expiration flow and actively support the patient's expiration by means of controlled ventilator piston return.

During intraoperative ventilation, especially after intubation, a recruitment manoeuvre may be indicated to resolve atelectasis evolved during intubation, maximise FRC and ideally to identify the patient's specific PEEP to avoid derecruitment.

One-step Recruitment Manoeuvre
Frequently, recruitment is being done as a single step recruitment switching the anaesthesia machine to Man./Spont. Mode, setting the APL valve to the anticipated alveolar opening pressure and pressing the ventilation bag (e.g. 40mbar for 40 seconds in normal weight patients). This approach is widely spread, but also carries disadvantages. Depending on the device used, the APL valve might not deliver the pressure to the patient as intended by the user. A recent study by Weiss et al. (Anaesthesia, 2017) found, that the pressures delivered by APL valves can deviate significantly from the pressure intended by the user, thus not allowing safe bag-assisted ventilation of a patient's lung. Dräger APL valves were found to deliver a linear pressure pattern and thus deliver pressures close to the pressure intended by the user.

As an alternative to this manual procedure, the Dräger Perseus A500 offers an additional functionality by which a one-step RM can be performed during normal ventilation. For this, the desired pressure level and the inflation time are set, then the manoeuvre can be started by the touch of a button. After the manoeuvre has been conducted, the device automatically switches back to the previously set ventilation. This ensures that the preset pressure and inflation time are kept reliably and that, following the manoeuvre, the desired PEEP will be maintained.

Multi-Step Recruitment Manoeuvre
The idea behind this manoeuvre is to carry out the alveolar recruitment, not only effectively, but also as gently as possible with respect to the lung and haemodynamics. In order to do so, inspiratory pressure and PEEP are ideally increased step-by-step while maintaining a constant driving pressure. The maximum inspiratory pressure (alveolar opening pressure) is maintained for a desired amount of time, after which both inspiratory pressure and PEEP are gradually decreased. Each stage is maintained for a user-defined time/number of breaths. By linking PEEP and inspiratory pressure, Dräger anaesthesia devices facilitate the manual implementation of these manoeuvres.

The Perseus A500 offers a procedure to automate the manual set-up effort for these kind of manoeuvres, which can take up to more than 5 minutes. The recruitment manoeuvre can be adjusted to suit the patient intuitively with just a few settings. The following two settings are the main parameters:
– Maximum inspiratory pressure
– Maximum PEEP

If so desired, further settings can be made, such as for driving pressure, number of mandatory breaths per pressure stage, and number of mandatory breaths while in the maximum pressure stage. While monitoring the manoeuvre, should the user determine that the objective of the recruitment has been achieved even before reaching the maximum pressure stage, Perseus® A500 offers the possibility of prematurely transferring to the decremental phase and to begin with gradual pressure decrease - all without having needed to exert the pre-set maximum pressure. During the decremental phase, compliance and tidal volume can be monitored during the pressure stages in order to determine patient-specific PEEP.

In any case, an adequate PEEP may be deployed in order to avoid derecruitment and the need for recurrent RM, potentially resulting in cyclic closing/opening of alveoli and corresponding stress and strain for the lung parenchyma.

Read more on alveolar recruitment in our clinical whitepaper (click here) and in the corresponding technology insights (click here).

Room to breath
Early spontaneous breathing of the patients supports the prevention of atelectasis, which is particularely important for obese patients. Therefore modern blower-based anaesthesia ventilators target to maximise the time in which spontaneous breathing is enabled. This technology enables spontaneous breathing in Pressure Controlled Ventilation and in PC-Autoflow not only during the expiratory phase, but also during the inspiratory phase of mandatory strokes (real BiPAP).

Mask fit

During pre-oxygenation and the induction of anaesthesia in obese patients, it is important that the CPAP and the pressure for Pressure Support should arrive at the patient with as little leakage as possible despite non-invasive application. It is therefore essential to select the correct mask size. Some obese patients also have a greatly increased amount of fatty tissue in the facial region, which can make it more difficult to achieve a good fit with the ventilation mask. In addition to selecting the correct size, it may be necessary to adjust the pressure of the mask cushion in order to get a good seal. Obese men should preferably be shaved so that beard hair does not affect the fit of the mask.

DGT-32.2017 | 17.06.2 | BM | Subject to modifications | © 2017 Drägerwerk AG & Co. KGaA

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