

# Standardization of the anesthesia for fully stapled laparoscopic Roux-en-Y gastric bypass surgery

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International Anesthesia submitted for public 2010,

## **Abstract:**

The bariatric surgical procedure requires specific anesthesia and pharmacologic knowledge. In the pre operative preparation for bariatric surgery anesthesiologists need some extra answers and measurements like body mass index (BMI) and waist to hip ratio (WHR) calculation and the request for android patients to loose sufficient weight by protein diet. Anesthesia induction focuses on facilitating mask ventilation and intubation with the prevention of atelectasis and aspiration. Improving the surgical outcome means optimization of the surgical workspace by giving sufficient muscle relaxation and using the beach chair position, helping to detect possible leaks during the intervention and preventing postoperative bleeding by increasing the systolic arterial blood pressure during the operation. Peep is kept above 7 cmH<sub>2</sub>O during the whole anesthesia to prevent atelectasis. Silent aspiration is further prevented during surgery with endotracheal cuffs without leak. Ventilation is switched early to pressure support being more physiologic and allowing early recovery after surgery with optimal morphine loading. After surgery full decurarisation is important as well as being full awake and breathing deep. Dillemans et al published recently the early immediate postoperative morbidity and mortality figures of 2606 consecutive gastric bypass operations using this anesthesia approach. It is difficult to account the impact of anesthesia on these exceptional good results. The anesthesia approach itself was built up gradual during this study evaluation and further improved when new scientific data became available.

## **1. Introduction**

Bariatric anesthesia requires specific knowledge. First, patients are morbid obese except re-interventions.<sup>1</sup> Secondly, laparoscopic workspace is frequently insufficient.<sup>2</sup> Surgical complications are focused to bleeding and leakage.<sup>3</sup> These are difficult to diagnose and to treat in morbid obese patients. Per-operative anesthesia focuses on drug dosage<sup>4</sup> and per operative ventilation while post operative care is focused on pulmonary complications.<sup>5</sup> The anesthesia approach can also reduce the incidence of surgical complications. This transdisciplinary work goes further than only teamwork. The anesthesiologist tries to improve the surgical outcome using our knowledge as anesthesiologist.

The proposed anesthesia technique here is not the only method that can be used. Different drugs and techniques are available with a comparable effect. Anesthesia is also dependent on the surgical methods used. Dillemans et al<sup>6</sup> published recently the early immediate postoperative morbidity and mortality figures of 2606 consecutive gastric bypass operations. We will discuss the anesthesia technique used using this anesthesia approach. It is difficult to account the impact of anesthesia standardization on these exceptional good results. The anesthesia approach itself was built up gradual during this evaluation and was further improved when new scientific data became available.

## **2. Pre operative preparation and questions.**

The medical history, allergy, drugs used, previous diseases and interventions are asked in detail as for any anaesthesia. Following extra questions are asked for laparoscopic gastric bypass surgery.

Correct evaluation of the obesity requires first total body weight (TBW) and length (L) to calculate the body mass index ( $BMI = TBW/L^2$ ). BMI above 40 means morbid obesity and above 50 means super obesity. They require frequently bariatric surgery but BMI is not enough to evaluate anesthesia and surgery risks. The Waist to Hip ratio (WHR) is calculated by dividing maximum waist circumference by maximum hip circumference. This categorizes the morbid obese patients as android (WHR >1,0) with a high risk or as gynoid (WHR <1,0) with a lower risk profile. In the android group it is important to know if the increased WHR is due to intra abdominal fat or due to extra abdominal fat between skin and fascia. Abdominal CT or MR imaging can measure this easily. Sonography<sup>7</sup> but also clinical inspection of the fat layer between skin and fascia reveals the distribution of the body fat volume. The intra abdominal fat lowers the abdominal compliance and increases the pressure at zero volume (PV0) to an extent in which it is difficult to ventilate the patient, where the surgeon will have no laparoscopic workspace to operate and where the patient will fail to breathe spontaneously.<sup>8</sup> The risk for cardio pulmonary diseases is higher.

The maximum body weight ever reached and the weight reduction achieved before surgery should be questioned if not set as goal before operation. If an android morbid obese patient did not achieve a minimum of 10 kg

weight reduction, it is better to postpone the surgery and offer a high protein diet for 3 weeks or a 6 months intra gastric balloon before surgery.

A question for a woman is the gravidity number as this enlarges the workspace and facilitates the ventilation even when childbirth was many years ago. The same effect is visible when laparatomies or long laparoscopy procedures took place in the past.<sup>9</sup>

Neck circumference of more than 50 cm is an indication for a difficult intubation in morbid obese patients besides the classical signs of mouth opening.<sup>10</sup> Again no sign is absolute and equipment should be available.

A history of sleep apnea requires the assessment of obstructive sleep apnea. If the patient uses a CPAP mask at home, ask to take it along to the hospital for post-operative use.<sup>11 12</sup>

Diabetes, chronic obstructive pulmonary disease, arterial hypertension, history of ethyl abuses and smoking habits can make recovery more difficult.

### 3. Pre induction preparation

Have the equipment to position the patient, to handle difficult intubation like video laryngoscope<sup>13</sup>, to give oxygen therapy and CPAP, to prevent aspiration at induction and to maintain anesthesia available before induction.

Beach chair position with elevated upper body before induction improves oxygenation.<sup>14 15</sup> If the operating table cannot be adapted use an upper body elevation pillow. Position before induction always an inflatable trapezoid pillow under the thorax between the scapulae to aligns the trachea with the hypo pharynx. This elongates the sterno mandibular distance and facilitates the intubation.<sup>16</sup>

Give oxygen by mask or better by CPAP like with a boussignac mask to prevent atelectasis.<sup>17</sup> Ask the patient to move the legs and to take deep breaths from time to time after awakening till the next day to prevent thrombosis, thromboflebitis and atelectasis, two frequent complications of anesthesia in morbid obese patients.

Have a good peripheral intravenous line. Look for a large blood pressure cuff on the upper arm or use the underarm. Use a non-invasive continuous finger cuff monitor if available.

If anesthesia might take more than 2 hours consider an arterial line and a central venous line. Provide then also an air blanket for warming up. Patients operated for the first time laparoscopic with no gravidity or a history of a low pain level gain a lot with a patient controlled epidural anesthesia. It might be difficult to position the epidural catheter but longer needles are not frequently needed.

Gargling of the oral cavity with an oral disinfectant and frequent teeth brush<sup>18</sup> before induction lowers the endotracheal tip contamination and might reduce pulmonary complications.<sup>19 20</sup>

### 4. Anesthesia induction and maintenance

Drug dosage is difficult in morbid obese patient.<sup>21</sup> At induction most hydrophilic drugs distribute in the lean body tissue. Using short acting drugs and monitoring its effect further simplifies the dosage.

Oxygen is given by mask or better by CPAP mask and induction is started when saturation reaches 95% or more. Induction dose in young morbid obese patient was standardized to the IBW for hydrophilic drugs. Dehydrobenzperidol 1,25 mg is given as anti emetic. Sufentanil 25 ug is followed by a remifentanil infusion according to blood pressure and heart rate. Propofol is started at 200 mg with additional boluses until loss of consciousness and followed by inhalation anesthesia.

Due to higher intra abdominal pressures in the obese patient mask ventilation is more dangerous for aspiration. Perform rapid sequence induction with cricoid pressure if super obese, android or coming for a revision.<sup>22</sup> Beach chair position will increase the barrier pressure only until anesthesia is giving.<sup>23</sup> Rocuronium is given in a minimum dose of 0,6 mg/kg IBW when manual mask ventilation is possible or in a dose of 1,2 mg/kg IBW when crush induction is needed. Clear drinks can be used up to 2 hours. The safety bird, an inflatable positioning pillow, is inflated till the sterno mandibular distance is more than 15 cm. The sniffing position of the head is kept with a pillow under the head.<sup>24</sup>

Gel applied on the endotracheal cuff will lower silent aspiration but a taperguard cuff or microcuff gives 100% protection. Immediately after intubation introduce a gastric tube French 34 gently in the stomach to drain air and gastric content out of the body. Never occlude or suction on the large gastric tube as combination with movement can damage the mucosa. Keep gastric tube separated from OTT to prevent accidental extubation during movement.

Measure depth of muscle relaxation. Start the rocuronium drip at 50 mg/h and increase when one TOF answer appears or lower when PTC is less than 10. Remifentanyl drip ( 2mg/50 ml) is started at 12ml/h (500 ug/h or 10ug/kg IBW/h) and increased when heart rate or blood pressure increases.

There is an advantage of inhalation anesthesia versus TIVA. TIVA needs adaptation according to BMI while inhalation concentration is independent of BMI. Bis or entropy monitoring can help to determine the level for both. Inhalation anesthesia does not suppress pressure support ventilation and has muscle relaxing effects at 2 Mac.

Inhalation anesthesia with Sevoflurane or Desflurane is given at 1 Mac and adapted according to entropy or bis level. At 2 Mac full relaxation is possible but hypotension and deep anesthesia at the end are not practical.

Nitrous oxide can be used safely if intubation was not difficult and no air was inflated in the stomach. It has its known negative effects like PONV and could be omitted.

Eye protection is required for methylene blue running out of oral cavity, medical instruments and cables lying on the patients' head. Gel is applied on the cornea without touching the cornea. Eyelids are closed and kept closed by an op-site covering the eye and preventing drying out. An eye protection a gauche is put over the eyes.

## 5. Pneumoperitoneum induction and the need for muscle relaxation

Abdominal compliance is linear in humans allowing the characterization of each abdomen with two parameters: Elastance E or its reciprocal the Compliance C and the pressure at zero volume PV0.<sup>25</sup> Prediction of abdominal compliance remains difficult. Nevertheless some factors like no gravidity, first laparoscopy or no weight reduction in young and sport active patients suggest possible small laparoscopic workspace and higher airway pressures in ventilation. Nevertheless the inter-individual variation in abdominal compliance is that large making the measurement in each individual patient necessary during laparoscopy. The effect of muscle relaxation varies also. Sufficient workspace at the lowest airway pressures requires that every patient should be maximal relaxed. Verify that muscle relaxation is sufficient deep at a TOF 0/4 measured at the thumb. Never rely totally on the TOF measurement only as the diaphragm is the muscle with the largest resistance against curarisation and the technology to measure TOF might fail. Verify with you hands the finger movements and exclude direct muscle stimulation.

Measure during the first inflation the starting pressure and the pressure at maximum volume. This gives you already a rough estimation of the E and PV0.

Correct measurement is possible when the first trocar is positioned. Measure three pressure volume points at around 1 liter difference. Stop each time the inflator and note the inflated volume as well as the lowest abdominal pressure indicating the end expiratory phase. Draw a linear line through 3 points and calculate PV0 as the crossing with the Y-axis and E as the angle of the line.<sup>24</sup>

Calculate the intra abdominal pressure needed to reach an abdominal volume of 4 liter. Set the inflator to this level or slightly higher. If more than 15 mmHg is needed verify that ventilation is not impaired and keep maximum muscle relaxation till the end. It increases the volume with 600 ml on average. This is the group of patients that might require Sugammadex for decurarisation.

Use the beach chair position, anti trendelenburg and leg flexion at the hips, to improve the volume with 700 ml on average for the same pressure.<sup>26</sup>

After the induction dose subsequent doses should be give in time and before surgeon is disturbed by insufficient place or no place when the patient breaths against the ventilator. The surgeon complaining of no place is always right, as can be the anesthesiologist too, in giving total muscle relaxation. Continuous infusion of rocuronium with TOF monitoring facilitates continuous maximum relaxation. If you give only bolus you might be too late. We start a rate of 50 mg/h and increase or decrease according to TOF.

Maximum relaxation is kept till the end of the pneumoperitoneum in all patients. Inhalation anesthetics relax the abdomen only when given in a high dose of 2 MAC. This can be used at the end of the pneumoperitoneum, but is not needed anymore with the use of Sugammadex. More over deep anesthesia to low bis levels should be avoided.

## 6. Ventilation of a morbid obese patient

Ventilation is focused to provide sufficient oxygen and CO2 removal but deals also with preventing atelectasis, volutrauma and silent aspiration. Keeping peep on above 7 from the beginning to the end is crucial.

Peep should therefore be given throughout the entire period as long as the patient is not able to sit up upright.

The peep should never be interrupted, even for a short moment. Start at a higher level after bag squeezing or need for expansion and come down but keep minimum level above 7 cmH2O<sup>27</sup>

If saturation remains low do not prolong the bag squeezing as other factors like low cardiac output could also explain low oxygen saturation.

There is no difference in outcome of controlled volume versus controlled pressure ventilation.<sup>28</sup> Therefore controlled volume ventilation is the first choice as it is safer to prevent hyperventilation and volutrauma or hypoventilation and hypercarbia due to changes in abdominal and thoracic compliance.

Nevertheless pressure controlled is chosen when airway pressures are very high as might be the case in android super obese patients.<sup>29</sup> Pressure controlled volume guarantee ventilation has a deceleration flow and prevents volutrauma. The loss of tidal volume variation however offsets the improved oxygenation obtained with pressure controlled.

Flexion of the legs increases the abdominal compliance and anti trendelenburg improves diaphragmatic displacement, both facilitating ventilation in android obese patients.

Frequency should rise if a tidal volume above 600 ml ( 9 ml/kg LBM) is needed to keep end tidal CO<sub>2</sub> below 40 mmHg. Hypercarbia is accepted towards the end of the pneumoperitoneum as it increases the cardiac output. This improves peripheral organ perfusion, what lowers wound infection, prevent ischemia at the staple lines and increases blood pressure needed to find bleeding spots on the staple lines. Most patients have chronic hypoventilation with hypercarbia making the need for normocarbia during surgery questionable. Pressure support ventilation is possible even in a patient under full muscle relaxation when the morphine dose is limited. At the end of the laparoscopy when end tidal CO<sub>2</sub> is allowed to raise pressure support can easily be started even during pneumoperitoneum. Breathing against the ventilator disturbs the surgeon while a ventilator following the patient's respiration will be almost not visible for the surgeon. Pressure support ventilation allows the up titration of the morphine dose till respiratory rate drops below 20 breaths per minute. If respiratory rate is below 10 support should be postponed.<sup>30 31</sup> When muscles regain force the support level can drop while keeping tidal volume. Peep should never be interrupted. When a support of 5 cmH<sub>2</sub>O is reached, the patients can breath spontaneous.

## **7. Assisting the surgeon in positioning the gastric tube and performing the leak test.**

Correct position of the gastric tube and emptying of the stomach is important for the surgeon. Never insert deeper if resistance is felt and learn to use the laparoscopic view when possible.

First deflate the stomach, never suction on the 34 French tube but keep tube always open and in drainage.

Retract the tube in the esophagus while keeping it open. After the first staple line introduce the tube slowly in the base of the gastric pouch created by the next stapler. Advance one centimeter to keep traction on the pouch while the surgeon dissects and places the third stapler. When the stapler is fixed ask to move the tube a little bit up and down to verify that the stapler is not put on the tube. When the pouch is created redrawn the tube again in the esophagus.

At the end of the operation the gastric tube is reinserted under laparoscopic view and stopped 5 cm below the gastro jejunostomy. The surgeon closes the descending jejunum and 150 ml methylene blue colored water is injected by the anesthesiologist as fast as possible to distend the gastric pouch. Tube is closed and 150 ml air is extra injected for further distension and evaluation of leakage. The tube is slowly withdrawn while opened to the air, to evacuate the water. Extra stitches are placed if needed. The tube is withdrawn in the esophagus and kept draining the fluids and air.

## **8. Blood pressure increase to prevent postoperative bleeding and revision.**

The quality of laparoscopic staples has increased in the last decennia improving tightness and preventing bleeding. However staples keep blood vessels open and prevent spontaneous collaps. Therefore some blood vessels might start to bleed post operatively when systolic pressure increases when patient wake up. An arterial pressure increase during the operation is important to visualize and correct possible bleeding.

At a SAP below 90 mmHg al staples lines are totally white without any bleeding spot. This might be nice for the surgeon to operate in a blood free workspace but gives also no information on perfusion adequacy.

At a SAP of 110 mmHg staples lines are oozing and get a red appearance.

At a SAP of 140 mmHg bleeding spots that otherwise might have missed could be visualized.<sup>32</sup>

The surgeon can easily put some extra manual stitches or a single staple on the blood vessel, better than to coagulate the staple line and impairing perfusion.

This also the good moment to verify that all tissue is well perfused and has a nice red color.

## **9. ERAS techniques to shorten turn over time and improve post operative recovery**

Early recovery after surgery (ERAS) starts at the induction. Many factors that favor ERAS are discussed before.

Avoid the use of long working sedatives like benzodiazepines as it is important to be full awake after the operation.

Inhalation anesthesia makes ERAS easier to apply. When rocuronium is used muscle relaxation is possible till the end, given Sugammadex is available.

Stop remifentanyl infusion and switch to pressure support ventilation below the level that was used during controlled ventilation while keeping peep.

Measure TOF and decide what decurarisation is needed to reach 90% at the end of surgery. If TOF < 2/4 2 mg/kg Sugammadex is given, if TOF is between 2/4 and 4/4 1 mg/kg Suggammadex is given. If TOF is 4/4 neostigmine is able to work sufficiently but Suggammadex might be used at a dose of 0,5 mg/kg to stimulate awakening. Sugammadex should be given when patient is fixed with belts after the last surgical stitch to prevent patient from falling of the OR table.

## 10. Extubation, postoperative assist and the decision for intensive care follow up.

Patient can be extubated when spontaneous tidal volume is more than 400 ml and patient is fully decurarized and awake.

First aspirate the oral cavity and go down with aspiration tube just into the gastric pouch. Emptying the stomach will make patient more comfortable and allows the visualization of any intraluminal bleeding. Never give 100% oxygen before extubation<sup>33</sup>.

Aspiration under cpap prevent lung atelectasis. Only a few anesthesia ventilators have this feature but a boussignac open cpap system allows aspiration during extubation with cpap, followed by cpap mask till lung is sufficient re opened and ready to breath with an simple oxygen mask. If saturation requires further postoperative CPAP at 5 cm H<sub>2</sub>O is safe and useful<sup>34</sup> and will not distend the gastric pouch.<sup>35</sup>

If Sugammadex is used the arousal effects might be that strong that the patient is able to move himself in bed.

If patient fails to breath sufficiently, do not wait until hypercapnia creates somnolence to support the ventilation.

## 11. Post operative pain treatment

Post operative pain treatment is important but less difficult in laparoscopy compared to laparotomy.

Multimodal therapy improves the efficiency.<sup>36</sup> Paracetamol should be given in a higher dose for morbid obese patients. M Margaron calculated the plasma levels in patients with BMI above 50 and found that 2 gram every 2 hour was able to maintain plasma levels continuously in the therapeutic range.<sup>37</sup> Elderly patients and patients with renal insufficiency requires lower doses. Today we have set our standard dosage at 2 gram loading dose and 2 gram every 4 hours in patients with a BMI above 40 .

Local wound infiltration of the trocar sites helps but does not block all pain stimuli.<sup>38</sup> The trocar incision internal closed with a stich and getting the drain needs local infiltration. Transversal abdominal plane block (TAP) although difficult in obese patients is promising for lower abdominal surgery but is more difficult and dangerous for upper abdominal surgery. Less diaphragm hyperextension and pain is seen in patients having had multiple laparoscopies or gravidities in the past. Patient controlled epidural analgesia is for primipara without previous laparoscopies useful and superior to patient controlled intravenous morphine.

Give sufficient Sufentanil at induction and titrate at the end when pressure support ventilation (PSV) is started.<sup>39</sup> If patient breathe more than 20 x /min a small bolus can be added till respiratory rate becomes 14. If respiratory rate is less than 10 wait with PSV.

Provide piritramide iv 5 mg when RR > 20 until patient is pain free

Provide 20 mg IM of piritramide and increase to max 30 mg according to patient characteristics.

Epidural anesthesia can be difficult in the super obese patient. However PCEA is superior in pain management and should be used when better pain treatment is needed like in patients with an abdomen that has never been overstretched before, patients with a long surgical procedure or a low pain threshold.

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