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SCIENTIFIC ARTICLE - CASE REPORT

ANESTHESIA FOR VIDEOLAPAROSCOPIC GASTROPLASTY IN A PATIENT WITH MORBID OBESITY WITH MONTGOMERY T-TUBE

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ABSTRACT

The Montgomery T-tube (MTT) is a silicone device used as a tracheal stent combined with a tracheostomy tube to prevent tracheal stenosis. The management of this device, the airways (AV) and mechanical ventilation (MV) of patients with TTM pose challenges to the anesthesiologist due to their relatively low frequency. In addition to the particularities conferred by the tracheal prosthesis, the patient in question underwent videolaparoscopic gastroplasty, which results in changes in respiratory mechanics and mechanical ventilation. This occurs both due to the increase in body mass and abdominal pressure resulting from obesity, and due to the inflation of the pneumoperitoneum.

Keywords: Obesity, Artificial respiration, Gastroplasty, Artificial intubation; Tracheal stenosis.

INTRODUCTION

The Montgomery T-tube (MTT) is a device introduced in 1960 that serves as a respiratory conduit and tracheal stent after laryngotracheoplasty. It is a silicone tube without a cuff, consisting of a long branch (intratracheal) and a short branch (extratracheal), extending through the tracheostomy stoma. Its sizes range from 4.5 to 16 mm in external diameter, allowing it to fit both adult and pediatric tracheas. The main indications for its use are post-laryngotracheoplasty (to keep the lumen open and prevent mucosal laceration due to scarring), tracheomalacia, recurrent polychondritis, post-tuberculous bronchostenosis, amyloidosis, tracheobronchial trauma, post-anastomotic bronchial stenosis, extrinsic compression, airway collapse, subglottic stenosis, and laryngotracheal reconstruction. [1-4]

Due to its infrequent use and the lack of familiarity associated with the device, the management of patients with the MTT (Montgomery T-tube) presents a challenge for anesthesiologists. The management of the device, the patient's airways (AW) with the MTT, and positive pressure ventilation during laparoscopic surgery are still underreported and not fully mastered.[4]

Among the difficulties encountered during the manipulation of the airways of these patients are

the possibility of displacements of the branches, due to the soft nature of the MTT, and the difficulty in maintaining controlled ventilation, as occlusion of the upper end of the intratracheal branch is required to prevent the loss of inspired gas. Additionally, standard catheter mounting connectors do not fit the shape of the MTT due to the variable internal diameter and the tube's thickness, which does not conform to the shape of the MTT. [1, 2]

In the preoperative evaluation, the feasibility of maintaining or the need to remove the MTT during the induction of general anesthesia should be assessed, in order to outline possible strategies for safely maintaining the patient's airway and methods for administering volatile agents and carrier gases.[2]

In addition to the careful assessment of whether to maintain or remove the MTT and the potential displacement during airway manipulation, attention should be paid to the ventilation of patients with this device. This is because, in addition to the narrowing of the airway passage, whether due to the need for a smaller diameter tube or the narrowing of the MTT itself, positive pressure, combined with the insufflation of the pneumoperitoneum, presents challenging characteristics in mechanical ventilation. This report aims to address the management of the MTT and the possible alterations encountered in mechanical ventilation during surgery and anesthetic monitoring in this class of patients.

CASE REPORT

A 31-year-old patient with grade 3 obesity (body mass index [BMI]: 49.13) and tracheal stenosis due to prolonged intubation during hospitalization for COVID-19 three years ago, with an MTT prosthesis (Figures 1 and 2) since then. The last prosthesis exchange was performed a year ago, with reports of significant desaturation and difficulty in performing the exchange. Bariatric surgery was indicated by a thoracic surgeon due to complications from the stenosis and recurrent exchanges of the Montgomery prosthesis, with the risk of developing respiratory complications, acute respiratory failure, and severe complications during prosthesis exchange due to obesity.

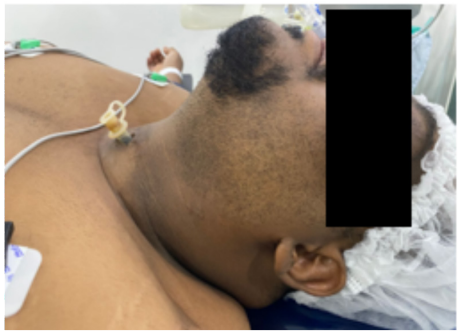

Figure 1: Extratracheal branch of the Montgomery T-tube.

Figure 2: Intratracheal branch of the Montgomery T-tube.

Echocardiogram within normal limits, ambulatory blood pressure monitoring and Holter without significant changes, electrocardiogram with sinus rhythm, duplex venous ultrasound of the lower limbs without changes, chest X-ray within normal limits, and total abdominal ultrasound showing marked hepatic steatosis.

In the airway assessment, the patient presented with Mallampati 1, upper lip bite test class 1, adequate cervical extension, cervical circumference greater than 40 cm, and an inter-incisor distance greater than 3 fingers. Positioning was performed with a specific pillow to align the oral, laryngeal, and pharyngeal axes, followed by pre-oxygenation with a mask (Figure 3). Peripheral venous puncture was performed with an 18G Jelco catheter. Monitoring included pulse oximetry, cardiograph, pneumatic cuff, bispectral index (BIS), gas analyzer, and capnography. The patient was admitted with a blood pressure of 160/90 mmHg, heart rate (HR) of 100 bpm, and 100% oxygen saturation.

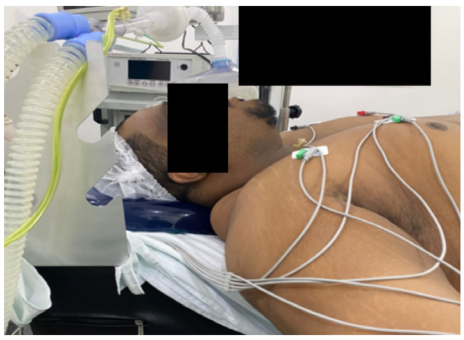

Figure 3: Placement of pillow and pre-oxygenation with a facial O_2 mask with alignment of the oral, laryngeal, and pharyngeal axes.

Surgical planning for laparoscopic gastroplasty and anesthetic planning for general anesthesia with awake intubation via fiberoptic bronchoscopy, with assistance from the thoracic surgeon as a precaution for prosthesis mobilization (Figure 4). The patient was informed about the anesthesia and awake intubation, and was aware and cooperative. Topical anesthesia was performed in the oropharynx with 2% Lidocaine spray, followed by pre-oxygenation with a 100% O_2 facial mask. Sedation was performed with 10 mcg Sufentanil, 40 mcg Dexmedetomidine, and 10 mg Ketamine. A fiberoptic bronchoscopy was conducted for airway evaluation (Figure 5). Pre-oxygenation was resumed with 100% O_2.

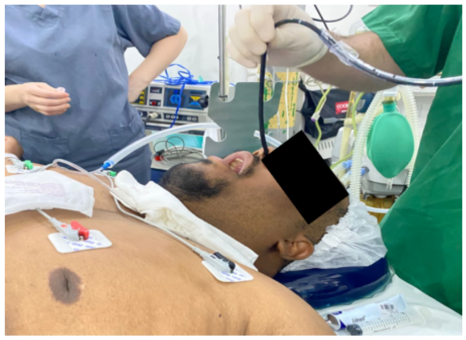

Figure 4: Fiberoptic bronchoscopy with the patient awake.

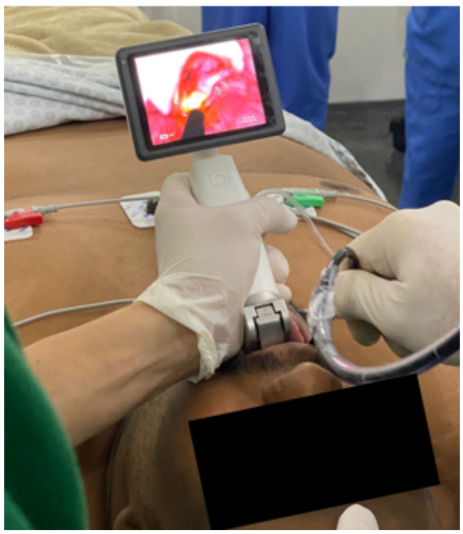

Figure 5: Video laryngoscopy with the patient awake.

After airway evaluation via video laryngoscopy, intubation was performed with bronchoscopy, assisted by the thoracic surgeon, with good visualization of the tracheal prosthesis. A 6-size cuffed tube was inserted with Lidocaine gel inside the MTT, with good patient tolerance, maintaining hemodynamic stability and hypoxemia up to 68%. After tube placement and cuff inflation, anesthetic induction was performed with 20 mg Ketamine, 50 mg Rocuronium, and 200 mg Propofol. After anesthetic induction, the patient remained hemodynamically stable, saturating 90-93%. An additional 50 mg of Rocuronium was administered at the start of the surgical procedure.

The patient maintained pressure-controlled ventilation during surgery with the following parameters: total flow of 2 liters, inspired oxygen fraction (FiO2) of 53%, respiratory rate (RR) of 14 breaths per minute (bpm), peak pressure of 32 mmHg, positive end-expiratory pressure (PEEP) of 4 cmH2O, expired volume of 600 ml, and an inspiratory:expiratory ratio of 1:2. Anesthesia maintenance was achieved with 1.1 MAC (minimum alveolar concentration) of Sevoflurane, maintaining an adequate anesthetic plan (monitored by BIS), with no need for additional doses of other anesthetics. Hemodynamic stability was maintained, and no vasoactive or vasopressor drugs were required.

At the end of the surgery, the patient was extubated in the operating room after the administration of 200 mg Sugammadex and adequate awakening guided by BIS, with no complications. The patient was maintained in the post-anesthesia recovery room (PACU) for two hours, receiving supplemental oxygen therapy via an oxygen mask (Figure 6).

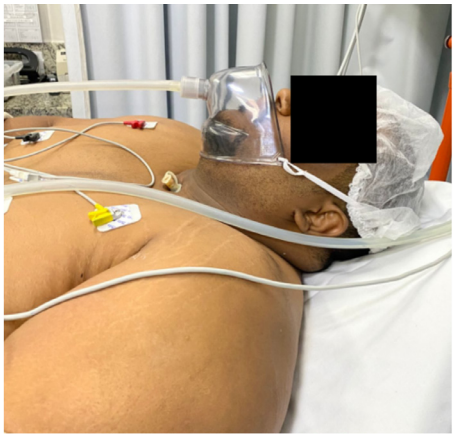

Figure 6: Patient in PACU with supplemental oxygen therapy via O_2 mask.

DISCUSSION

Patients with morbid obesity present altered respiratory mechanics due to the increase in body mass, as well as a two to threefold increase in intra-abdominal pressure compared to eutrophic patients. When undergoing laparoscopy, with the insufflation of pneumoperitoneum and the increase in intra-abdominal pressure, they experience an even more pronounced alteration in respiratory physiology. In the reported case, in addition to these factors, the patient had a MTT, a device used after laryngotracheoplasty that is infrequently used and poorly reported, presenting challenges both in terms of managing the device, the airway of the patient with the MTT, and positive pressure ventilation for laparoscopic surgeries.[5]

The MTT is a silicone device without a cuff, consisting of a long branch (intratracheal) and a short branch (extratracheal), which extends through the tracheostomy stoma. When handling it, there is a possibility of displacement of the branches, and maintaining controlled ventilation is challenging due to the need to occlude the upper end of the intratracheal branch to prevent the loss of inspired gas.[1]

Due to the soft material of the tube, displacement of the upper or lower branches may occur during tube insertion and manipulation. The MTT has the disadvantage of not fitting standard catheter connectors, unlike standard tracheostomy tubes, due to its variable internal diameter and tube thickness. Ventilation through the extratracheal branch is ineffective because of the open upper end of the intratracheal branch, which causes air leakage, making it difficult to maintain controlled ventilation. To prevent the loss of inspired gas, the upper end of the intratracheal branch of the tube must be sealed. Connecting the extratracheal branch to the anesthetic circuit for mechanical ventilation, through endotracheal tube connectors, combined with concurrent occlusion of the intratracheal branch using a balloon catheter, is an option. However, there is no specific balloon catheter or connector for the MTT, which does not ensure proper coupling and reliability of the connection. [1, 2, 4]

For ventilation with a facial mask and bag valve, the extratracheal branch should be occluded. If a laryngeal mask is used, the occlusion of the extratracheal branch should be performed simultaneously. However, this is contraindicated in patients with a high risk of aspiration.[1,4] The option of inserting the endotracheal tube through the extratracheal branch into the lower lumen of the intratracheal branch would have the advantage of securing the airway with the patient awake, prior to anesthetic induction. However, this technique is not feasible due to the smaller internal diameter of the extratracheal branch compared to the intratracheal branch, requiring a smaller caliber tube. Furthermore, the insertion is made more difficult due to the 90-degree angle between the two branches of the MTT.[4]

The alternative used in the case report was the insertion of the endotracheal tube with a cuff via the intratracheal branch of the MTT. It is necessary to evaluate the internal diameter of the MTT to select the appropriate endotracheal tube. Small tubes may cause high airway pressure and low tidal volume, while larger tubes can make passage through the MTT difficult and may displace it. A tomography scan can be used to measure the diameter of the branches.[4]

The preparation for intubation should include the preparation of medications to ensure the patient's comfort and the safe and successful management of the airway. The administration of anticholinergic agents helps reduce secretions but may induce stickier secretions. Hypnotic anesthetics and sedatives should be used to ensure patient comfort while maintaining respiratory drive. Muscle relaxants are essential to facilitate the passage of the endotracheal tube with less resistance. Topical/regional anesthesia with local anesthetics also contributes to the success of intubation, as does the lubrication of endotracheal tubes. Holding the extratracheal limb reduces the risk of unexpected removal or displacement of the MTT during intubation and extubation. Another important consideration is the proper coupling of the endotracheal tube cuff to the intratracheal branch wall of the MTT, guided by bronchoscopy, to prevent both leakage and damage to the branch wall. Bronchoscopy should be performed after intubation and extubation, under the supervision of a thoracic surgeon or an otolaryngologist, to detect possible abnormalities of the trachea or MTT and to insert an emergency tracheostomy tube or reinsert the MTT if necessary.4 Additionally, it is important to discuss with the thoracic surgeon or otolaryngologist the need for removal or replacement of the MTT with a new MTT or endotracheal tube, or the placement of a tracheostomy tube if severe tracheal obstruction or restenosis is detected.[4]

Laparoscopic surgery in the obese population requires special attention due to physiological differences related to increased body mass. Respiratory mechanics in obese patients undergo significant changes. Respiratory system compliance decreases exponentially as body mass index (BMI) increases, while airway resistance and pressure rise. The increase in BMI and intra-abdominal pressure directly impact ventilation, potentially leading to alveolar collapse. As a result, atelectasis, decreased functional residual capacity, and ventilation/perfusion ratio changes contribute to reduced arterial oxygenation and are common factors in surgeries that require peritoneal insufflation.[4,5]

The insufflation of pneumoperitoneum during laparoscopy in obese patients can lead to the systemic absorption of carbon dioxide (CO_2) and an increased need for CO_2 elimination. The rise in intra-abdominal pressure increases venous stasis, reduces intraoperative portal venous blood flow, decreases intraoperative urine output, lowers respiratory compliance, raises airway pressure, and impairs cardiac function. Intraoperative management to minimize adverse effects includes appropriate ventilatory adjustments to prevent hypercapnia and acidosis, the use of sequential compression devices to reduce venous stasis, and the optimization of intravascular volume to mitigate the impact of

increased intra-abdominal pressure on renal and cardiac function.[5]

In cases of orotracheal intubation requiring thinner tubes, airflow is compromised, leading to increased resistance and higher peak airway pressure. This occurs because airflow resistance varies inversely with the fourth power of the tube's lumen radius, according to Poiseuille's Law. As a result, with a reduction in the velocity of inspiratory and, especially, expiratory flows for the same lung volume, the patient will exhibit an obstructive ventilation pattern.[8]

Obese patients, who are treated as restrictive patients during mechanical ventilation, may also develop airflow obstruction when undergoing surgery with thin-caliber tubes, further complicating their ventilation and oxygenation. To mitigate the rise in peak pressure, one alternative is to increase inspiratory time, as this reduces inspiratory flow, given that inspiratory time and flow are inversely proportional. As inspiratory time increases, the predetermined tidal volume is delivered to the lungs more slowly. However, increasing inspiratory time affects the inspiratory-to-expiratory ratio, leading to a reduction in expiratory time. This must be carefully monitored to ensure that expiratory pressure returns to predetermined PEEP values, preventing an increase in intrinsic end-expiratory pressure (auto-PEEP). Studies indicate a positive correlation between body mass index (BMI) and the occurrence of auto-PEEP, identifying BMI as a predictive variable for its development.[8]

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