The evolution of anesthesia management of patients with anterior mediastinal mass

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Abstract: Anesthesia management of patients with mediastinal mass compressing the central airway is considered challenging. It is widely believed that general anesthesia induction in patients with mediastinal mass is associated with airway collapse, difficulty in ventilation and hemodynamic compromise. Additionally, several case reports and case series described patients demise after induction of general anesthesia. This has led to the strong recommendations to use inhalation induction, avoid the use of muscle relaxant and maintenance of spontaneous ventilation. Recent studies shed new light on our understanding of airway changes associated with mediastinal mass by directly visualizing and measuring the actual changes of the airway caliber and the variation in the peak inspiratory flow (PIF) and peak expiratory flow (PEF) in patients with mediastinal mass. These studies describe the changes in airway mechanics in different states e.g., awake and anesthetized, spontaneous and positive pressure ventilated with or without muscle relaxation. Interesting new findings in these recent publications show that general anesthesia with and without muscle relaxation does not worsen a pre-existing narrowing of the airway compressed by mediastinal mass. Moreover, it was discovered that the addition of positive pressure ventilation, positive end-expiratory pressure (PEEP) and muscle relaxation in an anesthetized patient were associated with improvement in the airway caliber and airflow in these patient's population. This new understanding of the mechanics of airway obstruction and the effects of anesthesia and mechanical ventilation on patients with mediastinal mass challenges our current anesthesia practices and leads us to consider a new approach to anesthetize and ventilate these patients. This article will review the past literature that led to the widely practiced current anesthesia techniques and how it is challenged with the new research. The author will also provide a new perspective and anesthesia technique that align with the new research findings for safe induction and maintenance of general anesthesia in patients with mediastinal mass.

Keywords: Mediastinal mass; anesthesia; airway collapse; muscle relaxant; hemodynamic collapse

Received: 29 August 2022; Accepted: 23 February 2023; Published online: 06 March 2023.
doi: 10.21037/med-22-37
View this article at: https://dx.doi.org/10.21037/med-22-37

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Introduction

Background

When an anesthesiologist encounters a patient with anterior mediastinal mass requiring general anesthesia, the concepts of airway collapse, vascular collapse (1,2), inability to ventilate, high airway pressures, and the possibility of patient's demise come to mind. Traditionally, inhalation induction, awake intubation, strong recommendations against the use of muscle relaxant and maintenance of spontaneous ventilation are all believed to be lifesaving anesthesia induction techniques (3-5). Due to the ever-present possibility of the patient's demise during anesthesia induction, the anesthesiologists are trained to always have a backup plan in the event of a catastrophe. Plan B includes, changing the patient position, rigid bronchoscopy, extracorporeal membrane oxygenation (ECMO) (6-9) and eventually waking the patient up from general anesthesia (10,11).

Rationale and knowledge gap

Literature search aimed at finding the origin of the above-mentioned complications associated with induction of general anesthesia and the anesthesia techniques recommendations to safely induce general anesthesia in patients with mediastinal mass, yields mostly case reports and a few case series. Case series and case reports do not compromise the highest level of scientific evidence. However, due to the gravity of the outcomes associated with anesthesia induction in patients with mediastinal mass, the case reports and case series with their author's plausible explanations of the cause of hemodynamic and ventilatory collapse, and recommendations for safe methods of anesthesia induction continued to be published and practiced (11). It is also important to note that, the rarity of encountering patients with mediastinal mass causing significant central airway compression has added to the inability to perform a systematic randomized study, as it would take years to have the appropriate sample size to reach a valid, significant conclusion.

Objective

In this article, historic data of case reports and case series and the new emerging data that contradict and/or attempt to explain the long-standing belief of the ventilatory and vascular collapse associated with anesthesia induction in patients with mediastinal mass will be reviewed. The author will also provide the culmination of 20 years' experience of managing the anesthetics of patients with mediastinal mass undergoing rigid bronchoscopy at a tertiary academic Cancer Center. Suggestions for future studies to better understand the hemodynamic and ventilatory changes in patients with mediastinal tumors undergoing general anesthesia will also be addressed.

Historical data

The earliest published recommendations for airway management of a patient with tracheal obstruction was a review article by Gordon in the *International Anesthesiology Clinics Journal* in 1972 (12). The author made the keen observation that the effective diameter of the trachea may be reduced to 3–4 millimeters before an otherwise healthy patient may complain of distress at rest. He also commented that the degree of the tracheal obstruction is influenced by volume and rate of air flow during ventilation, by phase of respiration, and by position in patients undergoing general anesthesia. Gordon provided the following recommendations for safe airway management in patients with mediastinal mass requiring general anesthesia:

(I) Preoperative assessment of the diameter of the obstructed tracheal lumen using chest X-ray films;
(II) Selection of an appropriate size endotracheal tube (ETT) based on the estimated tracheal lumen and advocated for the use of flexible armored ETT;
(III) Insertion of the ETT past the obstruction to secure the airway;
(IV) Direct bronchoscopic visualization of the tip of the ETT to ensure that the obstruction is bypassed;
(V) Introduction of the ETT over the bronchoscope in the event that difficulty is encountered in passing the ETT past the obstruction.

Gordons hypothesized that "In some cases, the induction of anesthesia and particularly the paralysis of the action of the voluntary muscles may result in collapse of the trachea and complete occlusion of the airway. In these circumstances, the anesthesiologist may introduce the ETT under topical anesthesia and during spontaneous ventilation in a conscious patient".

Gordon also recommended the avoidance of hyperventilation once the patient is intubated. He went on to explain that "patients with chronic obstruction of the trachea may have compensated respiratory acidosis and high $PaCO_2$. Hyperventilation will cause an abrupt and significant reduction of the carbon dioxide resulting in metabolic alkalosis, which in some instances will result in the reduction of the cardiac output, collapse of the cardiovascular homeostatic mechanisms and cardiac arrest”.

The earliest case report of airway management in a patient with mediastinal mass compressing the airway was in 1973 in the *British Journal of Anesthesia* (13). A 13-year-old who presented with increasing dyspnea, orthopnea, facial swelling, hypoxemia, and carbon dioxide retention leading to stupor. The patient was intubated awake with an ETT and difficulty with ventilation with high airway pressures was encountered. Bronchoscopy showed severe tracheal, carinal, and bilateral mainstem compression. As the compression of the right mainstem was less severe than the left mainstem, the reporting physician elected to place a longer ETT into the right mainstem. The patient was mechanically ventilated while he received 4 days of radiation therapy. Fortunately, the tumor decreased in size and the patient was successfully extubated. Interestingly, this early report of airway management in a patient with mediastinal mass compressing the airway was a successful management with a reported good outcome. In their discussion, the authors commented on the ventilatory parameters used during the mechanical ventilation of the patient stating that “in order to ensure complete expiration, however, an unusually long expiration time is necessary. In addition, marked hypotension may occur as a result of the high intrathoracic pressure, and the danger of progression to complete airway obstruction is always present”. Even though the authors were able to manage the airway successfully and safely with intubation past the obstruction, they remained aware of Gordon’s warning of complete airway collapse. The authors were the first to make the keen observation of air trapping, hyperinflation, and its effect on the hemodynamics. They were the first to recommend prolongation of the expiratory phase of respiration to avoid the air trapping.

The first case report of reverting to spontaneous ventilation when ventilation difficulty is encountered after muscle paralysis was a case report published in 1975 by Bittar *et al.* (14). In this case, a 19-year-old boy with lymphomatous superior mediastinal and chest wall mass was scheduled for excision of the chest wall mass. Preoperative chest film revealed tracheal and right main stem narrowing. Induction with thiopental and morphine caused apnea with difficulty to assist the ventilation manually. Succinylcholine infusion was started with no improvement in the ventilation. The succinyl choline infusion was stopped and adequate spontaneous ventilation was regained. The ventilation remained adequate and spontaneous with Face mask and nitrous oxide, morphine, and thiopental for the remainder of the procedure. 20 days later, the patient was scheduled for a staging laparotomy. Induction with thiopental, morphine, succinylcholine was uneventful. The patient was intubated with size 7 ETT. The peak airway pressure was 35 cmH_2O and the right hemithorax was not moving with ventilation and no breath sounds were detected on the right. The surgery was aborted, and the patient was awakened from general anesthesia to receive radiation therapy before another attempt at the surgery.

This case report emphasized and referenced Gordon’s hypothesis that any trachea restricted by tumor may collapse and yield complete airway occlusion if the action of the voluntary respiratory muscles is paralyzed during induction of anesthesia. However, Bittar went on to recommend that “if evidence of central airway obstruction is found, surgery should be delayed till the lymphoma is irradiated and the tumor has shrunken”. In his discussion, Bittar explained the mechanics of the central airway obstruction by stating “During spontaneous inspiration, the pleural pressure is negative to the atmospheric pressure. Inspiratory forces, therefore, exert a potential widening of the airways greater than that resulting from the increased elastic recoil (caused by increased lung volume) during inspiration. During expiration, the caliber of the airways decreases as lung volume decreases, but dynamic compression plays a significant role in further decreasing the caliber of the large airways, especially during forced expiration”. Bittar also hypothesized that paralysis of the airway smooth muscle plays an additional role in the obstruction. In his conclusion Bittar stated that “It is conceivable, therefore, that the compromised airway in this patient remained patent during spontaneous ventilation, as a result of the basic mechanics of respiration. Similarly, because the skeletal muscles were paralyzed and the smooth muscles were relaxed during general anesthesia, airway obstruction occurred”. It is noteworthy that, in this case report, the author encountered difficulty in ventilation before the succinylcholine infusion was started which is not completely explained by his hypothesis.

The first retrospective case series study of patients with Hodgkin’s lymphoma who underwent surgical procedure between 1969 and 1973 was published by Hellman *et al.* in 1976 (15). In the late 1960s to early 1970s, patients with newly diagnosed Hodgkin’s lymphoma were required to have exploratory laparotomy and splenectomy to determine the stage and appropriate therapy of the disease. Retrospective review of 139 patients who underwent 203 procedures, of which 176 required endotracheal intubations were performed. Mediastinal and hilar masses were found in 74 of the 179 who underwent general anesthesia with intubation. Evidence of airway obstruction before surgery was found only in 19 out of the 74 patients. Difficulty in ventilation around the time of intubation was encountered in only 2 of these 19 patients. The first patient had tracheal deviation and right main stem narrowing and the second patient had narrowing of the right bronchus intermedius and the left main stem. In both cases the procedure was successfully completed after adjusting the ETT to bypass the obstruction. This case series highlights the rarity of encountering patients with significant central airway obstruction by a mediastinal mass and the fact that both cases were successfully managed without catastrophic outcome when the obstruction was bypassed by the ETT.

The first reported death on induction of general anesthesia in a patient with mediastinal mass was in 1981 (16). A 9-year-old boy who presented with subacute onset of dyspnea on exertion, orthopnea, fever, and acute syncope and cyanosis while bearing down with a bowel movement. Inhalation anesthesia induction with Halothane was performed in a semi sitting position. Despite adequate ventilation, the patient became cyanotic and bradycardic. Endotracheal intubation in the supine position ensued with no difficulty in ventilation. Chest compression and cardiopulmonary resuscitation (CPR) failed, and the patient progressed to asystole. Postmortem autopsy revealed a large mediastinal tumor encasing and heart and infiltrating the pericardium. It is important to note that, no difficulty in ventilation was encountered in this patient making the airway collapse an unlikely cause of death. This article drew attention to the importance of preoperative assessment of cardiac involvement in patients with mediastinal mass and its effect on the obstruction of the venous return and/or cardiac output. Syncope while bearing down heralds the detrimental effect of the increase in positive intrathoracic pressure while bearing down on the circulation. This should alert the anesthesiologist that such detrimental effect of positive pressure on the circulation is likely to be reproduced when positive pressure ventilation under general anesthesia is initiated.

Multiple case reports demonstrated the use of ECMO in patients with mediastinal mass undergoing procedures. One example is a case report by Landa *et al.* in 2021 where a 70-year-old male with a right para-tracheal mass extending into the anterior mediastinum and causing 90% tracheal obstruction required surgery for tumor debulking and tracheal stent placement (17). It was noted that the superior vena cava (SVC) was patent with no mass effect by the tumor. Preoperative left internal jugular and left radial artery catheters were inserted. Sedation with Ketamine was started before the surgeon cannulated the internal Jugular vein and left femoral vein and ECMO was initiated. General anesthesia was then induced with Ketamine and rocuronium, laryngeal mask airway (LMA) was placed, and pressure-controlled ventilation ensued. Bronchoscopy showed the 90% tracheal obstruction with adequate mechanical ventilation and stable hemodynamics. The tumor was debulked and a tracheal stent was placed before the ECMO was stopped, the patient was awakened and the LMA was removed. The authors highlighted the ECMO's ability to provide adequate gas exchange and hemodynamic support in patients with severe central airway obstruction requiring surgery. More interestingly, this article was the first report of a patient being adequately ventilated through an LMA despite a 90% tracheal obstruction. Emerging data in 2021 recommend the use of ECMO for cases of central airway obstruction and cardiac involvement (18,19).

Emerging data

First comparison of peak inspiratory flow (PIF) and peak expiratory flow (PEF) and tidal volumes in patients with extrathoracic upper tracheal stenosis during spontaneous and positive pressure ventilation through a laryngeal mask airway was published in an observational prospective study in [2008] (20). In this publication, 30 patients with post intubation or idiopathic laryngotracheal stenosis (average 3 cm below the vocal cord) requiring surgery to restore the lumen of the airway were studied. The patient's baseline spirometry and flow volume loops were recorded. General anesthesia with muscle relaxation was induced before a LMA was inserted. All patients were ventilated with a driving inspiratory pressure of 20 cmH_2O, respiratory rate of 10 and Inspiratory:Expiratory (I:E) ratio of 1:1 to minimize auto PEEP (positive end expiratory pressure). The patient's tidal volumes and flow volume loops under general anesthesia were recorded using the anesthesia machine monitor. The findings were

(I) Awake spontaneously ventilating patients had significantly low PIF and PEF with a more pronounced effect on the PIF, causing an increase in the PEF/PIF ratio (mean 2.4);
(II) When the same patient is placed under positive

pressure ventilation with muscle paralysis, there was a decrease in the PEF/PIF to a mean of 1 mostly due to improvement in the PIF with positive pressure ventilation with little to no effect on the PEF.

At their conclusion, the authors stated that "Spontaneous ventilation creates negative inspiratory intratracheal pressure that exacerbates an extrathoracic lesion, whereas positive-pressure ventilation generates positive intratracheal pressure that improves ventilation. This helps explain the apparent resolution of airway obstruction after positive-pressure ventilation". The successful use of 1:1 I:E ratio in this case series of patients with variable extrathoracic airway obstruction is due to the absence of air trapping as air flow limitation is more pronounced during inspiration than during expiration. Interestingly the author also concluded that "Positive-pressure ventilation through an LMA is an effective method of ventilating patients with laryngotracheal stenosis".

The most recent measurement of PIF and PEF in patients with anterior mediastinal mass undergoing noninvasive positive pressure ventilation was published in 2022 (21). In this report Fiorelli *et al.* recorded the peak inspiratory and expiratory flows in 13 patients with anterior mediastinal mass causing tracheal narrowing requiring stenting. The patients were in supine position with face mask applied and connected to a ventilator circuit. The flows were recorded while the patients were spontaneously ventilating and when non-invasive positive pressure ventilation (NIPPV) was applied with a PEEP of 10 cmH_2O. The authors' findings indicated that extrinsic tracheal compression causes impairment of the PIF > PEF with an increase in the PEF/PIF ratio. When NIPPV is applied there was an improvement in both PIF and PEF with a more marked effect on the PIF > PEF causing the PEF/PIF ration to decrease. These findings showed that positive pressure ventilation (NIPPV) with a PEEP of 10 cmH_2O exerts a modest increase in peak flows and a more pronounced effect on both inspiratory and expiratory volumes in an awake patient with central airway obstruction.

The first case report visualizing the increase in the airway diameter under general anesthesia with positive pressure ventilation was reported in 2018 by Hartigan *et al.*, in the *New England Journal of Internal Medicine* (22). In this case report a patient with an anterior mediastinal mass compressing the trachea, main stem bronchi and SVC was intubated awake. Video bronchoscopy was taken of the carina and the mainstem bronchi before and after administration of general anesthesia while the patient was in a sei-fowler position. The airway videos showed a decrease in the airway caliber after general anesthesia induction followed by an increase after muscle paralysis and the institution of positive pressure ventilation. Noteworthy, the addition of paralysis to the positive pressure ventilation did not confer further increase in the airway caliber indicating that the positive pressure incurred by the ventilation was able to expand the central airway caliber more than negative pressure during spontaneous ventilation. This was the first directly visualized evidence that positive pressure ventilation is superior to spontaneous ventilation in preventing airway collapse or decrease in airway caliber under general anesthesia. Interestingly, the author reported using ventilatory parameters during induction that mimicked the patient's ventilatory rate, volume and time while spontaneously ventilating. The authors hypothesized that mimicking the spontaneous ventilation mechanics would prevent air trapping that contributes to increased airway pressure and hemodynamic collapse previously reported with assisted ventilation. In the authors response to letters to the editor, they stated that "Airway caliber is affected by tracheal transmural pressures, which can be equivalently achieved by positive intraluminal or negative extraluminal (pleural) pressures". And that "Matching the volume-time ventilatory pattern of positive-pressure ventilation to that of spontaneous ventilation may also be protective".

First prospective observational study of bronchoscopic evaluation of airway caliber changes under general anesthesia and muscle relaxation in patients with central airway compression was published by Hartigan *et al.* in the *Journal of Anesthesiology* in 2022 (23). In this single center study, 17 adult patients (12 with anterior mediastinal mass, 1 with posterior mediastinal mass and 3 with both anterior and posterior mediastinal mass) were intubated awake in a semi-sitting position with 8.5 mm ETT or LMA after upper airway topicalization with lidocaine. A staged induction ensued while the compressed airway was continuously visualized by video bronchoscopy. Four ventilatory stages were studied: awake spontaneous ventilation, anesthetized spontaneous ventilation, anesthetized positive pressure ventilation, and anesthetized positive pressure ventilation after muscle paralysis. It is important to note that the authors maintained the same tidal volume, respiratory rate, and I:E ratio throughout the 4 phases being studied. The findings were:

(I) No significant changes were noted in the anteroposterior compressed airway diameter between awake spontaneous ventilation and anesthetized spontaneous ventilation. Most importantly, there was no reduction in the airway diameter after induction of general anesthesia, positive pressure ventilation or the addition of muscle paralysis.

(II) There was a reported visual subjective improvement in the airway patency with the institution of positive pressure ventilation that persisted and further improved after muscle paralysis.

Reconciling the past and the present

Recent publications between 2018 and 2022 directly visualized and measured the actual changes in volumes, air flows and airway caliber in patients with obstructed central airway during inspiration, expiration with awake spontaneous ventilation, anesthetized spontaneous ventilation, and paralyzed mechanical ventilation. These newfound understandings explain the successful airway management and the causes of ventilation difficulties and catastrophic outcomes in the earlier case reports and case series between 1970s–1990s. In conclusions these findings are:

(I) *During awake spontaneous ventilation* in a patient with central airway obstruction, the negative pressure generated by inspiration causes widening of the central airway with an improvement of the inspiratory flow. During expiration, the airway narrows, and a prolonged expiratory phase enables the exhalation of the inspired tidal volume through the narrowed airway. These mechanics remain unchanged after the patients are anesthetized while maintaining spontaneously ventilating.

(II) *During anesthetized positive pressure ventilation*, the positive pressure of the inspiratory phase increases PIF and widens the central airway. Meanwhile, during the expiratory phase, the absence of positive pressure causes the central airway to collapse back to its narrow baseline, and the PEF remains unchanged resulting in air trapping, lung hyperinflation and subsequent hemodynamic compromise. Consequently, adjusting the ventilator settings to prolong the expiratory time or mimic the spontaneous ventilation volume, respiratory rate, and I:E is essential to recreate the prolonged expiration seen in awake spontaneously ventilating patients and allow for complete exhalation of the inspired tidal volume through the narrowed airway. A low respiratory rate can be an added advantage by allowing for more time to drive the inspiratory volume through the obstructed airway while maintaining prolonged expiration to prevent air trapping.

(III) *During anesthetized positive pressure ventilation with muscle relaxation*, it is clear from the recent studies that the administration of muscle relaxation in an anesthetized patient with central airway obstruction did not cause further changes in the PIF, PEF, or airway caliber making it a reasonable component of the general anesthesia plan in patients with central airway obstruction.

(IV) *The causes of hemodynamic collapse* encountered once the patients are anesthetized can be multifactorial and can be explained by

   (i) *Progressive air trapping* if the appropriate ventilatory parameters are not utilizedcan cause detrimental increase in the intrathoracic pressure with subsequent decrease in the venous return and cardiac output leading to hemodynamic collapse.

   (ii) *Tumor compression of the heart* causing mechanical obstruction of the venous return and cardiac output that can be worsened by the addition of positive pressure ventilation and hypovolemia. ECMO would be an ideal technique to maintain adequate circulation and tissue perfusion in patients with evidence of mechanical compression of the heart and its inflow and outflow tracts.

   (iii) *Hyperventilation* in patients with compensated respiratory acidosis causes rapid elimination of the carbon dioxide (CO_2) that can lead to respiratory alkalosis. Respiratory alkalosis causes intracellular shift of K and Ca, hypotension and impairment of cardiac function that may contribute to the hemodynamic deterioration.

Airway management for patients undergoing surgical resection

Adequate preoperative assessment of the location and degree of obstruction using computed tomography (CT) scan is essential. The size and the length of the ETT to be used should be selected to enable the passage through and past the area of critical obstruction. The use of armored ETT is recommended to avoid the external compression of the ETT by the tumor. Flexible bronchoscopy can be used to aid in the introduction of the ETT through the obstructed airway and to confirm that the tip of the ETT is past the obstruction.

Airway management for patients undergoing rigid bronchoscopy and stenting procedure

LMA or a rigid bronchoscope is more suitable airway devices for patients undergoing a procedure for central airway stent placement. The insertion of the LMA at the beginning of the procedure allows for complete examination of the entire airway, planning the stent size, length, location, and deployment of metallic stents. Meanwhile the rigid bronchoscope can be used to stent the airway open in patients with critical airway stenosis and ventilation difficulty. The deployment of silicon stents can only be achieved through the rigid bronchoscope.

Total intravenous anesthesia (TIVA) *vs.* inhalation induction

Historically, inhalation induction is the recommend anesthesia induction technique in a patient with mediastinal mass causing central airway obstruction requiring surgery. This recommendation is based on the belief that spontaneous ventilation should be maintained during induction of anesthesia to avoid airway collapse. It has clearly been shown in the above-mentioned reports that positive pressure ventilation is superior to spontaneous ventilation both in an awake and anesthetized patient due to its effect in widening the compressed airway and increasing the PIF during inspiration. Additionally, the use of muscle relaxant has been shown to cause a minimal increase or no effect on the airway caliber, PIF and PEF. In fact, the emerging data refute the fear of using intravenous induction with muscle relaxation.

Author's experience

In the author's practice at MD Anderson cancer Center, rigid bronchoscopy for airway stenting in patients with central airway obstruction is provided in the bronchoscopy suite as an outpatient procedure. A stepwise induction of general anesthesia and transition to positive pressure ventilation and muscle relaxation is commonly performed and was recently published in the *Anesthesiology News* Airway supplement in 2019 (24).

(I) Slow intravenous induction with propofol infusion in a semi sitting position to avoid acute changes in the hemodynamics associated with the administration of a propofol bolus.
(II) Continuous measurement of the tidal volume and airway pressure during induction by applying the anesthesia circuit's face mask to the patient to monitor for adequate air exchange.
(III) Muscle relaxation and positive pressure ventilation with an I:E ratio of 1:4 and low respiratory rate to avoid air trapping.
(IV) Insertion of the rigid bronchoscope past the obstruction area to stent the airway open and relief any air trapping during the anesthesia induction.
(V) In the event of hemodynamic compromise secondary to air trapping and the inability to pass the rigid bronchoscope past the obstruction, passing the flexible bronchoscope past the obstruction and applying suctioning can relief the air trapping and lung hyperinflation with restoration of the hemodynamics.

Future perspective

Based on the new literature describing the respiratory mechanics and airflow in patients with mediastinal mass, new guidelines and best practices of anesthesia induction and mechanical ventilation parameters are needed. Future studies should include analysis of the changes in inspiratory and expiratory tidal volumes, airway pressures, air trapping, auto PEEP and blood gas analysis in both awake and anesthetized patients with and without muscle relaxant. Identification of the most appropriate parameters and modes of mechanical ventilation, such as tidal volume, I:E ratios, PEEP, volume *vs* pressure-controlled ventilation, is essential to ensure hemodynamic stability under anesthesia.

Studies are also needed to compare the effects of inhalation induction and intravenous induction on the respiratory parameters during spontaneous ventilation. Additionally, reliable, reproducible actual measurement of airway caliber should be pursued to understand the correlation between different ventilatory settings, modes of ventilation and changes of the airway diameter.

In the author's opinion, the effect of the mediastinal mass on the ventilation should be studied. Positive pressure ventilation causes displacement of the membranous posterior wall of the tracheal and main stem bronchi, contributing to the increase in the central airway caliber during inspiration. Patients with posterior, lateral and/or bilaterally compressing mediastinal mass exhibit significant limitation of the movement of the posterior membrane that can be more challenging to ventilate than patients with anterior mediastinal mass. Further studies comparing anterior, posterior, and lateral mass effect on the respiratory parameter and ventilation are needed.

Conclusions

This review article spans a long period of time of reports and research publications describing the anesthetic risks and management in patients with mediastinal mass. Our knowledge has evolved from scientific interpretation of the plausible causes of the patient's demise and airway complications associated with anesthetic management of these patients, to actual direct visualization and accurate measurement of the mechanics of the airway changes and respiratory restrictions associated with mediastinal mass. Proper utilization of positive pressure ventilation and muscle paralysis appear to confer wider airway caliber and better airflow in contradiction to our previous beliefs. The new knowledge leads us to consider a new perspective for the anesthesia management of patients with compromised airway secondary to mediastinal mass. Further research is needed to delineate the appropriate ventilation parameters, and best anesthesia practices to provide safe anesthetics in patients with mediastinal mass.

Acknowledgments

Funding: None.

Footnote

Provenance and Peer Review: This article was commissioned by the Guest Editors (Bruce Sabath and Roberto F. Casal) for the series "Management of Airway and Vascular Invasion in the Mediastinum" published in *Mediastinum*. The article has undergone external peer review.

Peer Review File: Available at https://med.amegroups.com/article/view/10.21037/med-22-37/prf

Conflicts of Interest: Both authors have completed the ICMJE uniform disclosure form (available at https://med.amegroups.com/article/view/10.21037/med-22-37/coif). The series "Management of Airway and Vascular Invasion in the Mediastinum" was commissioned by the editorial office without any funding or sponsorship. The authors have no other conflicts of interest to declare.

Ethical Statement: The authors are accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

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doi: 10.21037/med-22-37
Cite this article as: Sarkiss M, Jimenez CA. The evolution of anesthesia management of patients with anterior mediastinal mass. Mediastinum 2023;7:16.