

Perioperative upper airway edema: Risk factors and management

Jonas P. DeMuro, Michael N. Mongelli, Adel F. Hanna

Abstract

Objectives: To study the risk factors and treatment of the postoperative patient who develops upper airway edema.

Design: Retrospective analysis.

Setting: Surgical Intensive Care Unit (SICU) of a tertiary care hospital.

Patients and participants: We performed a retrospective analysis over 24 months of SICU admissions of postoperative patients. Inclusion criteria were (1) failure to extubate after a surgical procedure, (2) a negative cuff leak test immediately postop (<110 mL of tidal volume loss with the cuff deflated), and (3) failure to extubate within 24 hours with suspected airway edema. Six patients met criteria for study.

Interventions: Management of these patients included a multimodal strategy including a daily cuff leak test, use

of corticosteroids, diuretics, and head of bed elevation.

Measurements and results: All patients were female, with a mean age of 54.5-year-old. The majority had operations remote from the neck region. The mean body mass index (BMI) was 34.8, and the mean surgical time was 282 minutes. Two thirds of the patients were given blood products intraoperatively with a mean of 17.3 units transfused. The mean fluid balance intraoperatively was +5 L. Using our protocol, steroids were administered in the equivalence of 389 mg of hydrocortisone across a mean of 71 hours of mechanical ventilation. Simultaneously, they received a mean of 63 mg of furosemide to achieve a mean fluid balance of -2.8 L. All patients were extubated when the cuff leak became positive; none required reintubation.

Conclusion: A multimodal strategy for the patient with postoperative upper airway edema is recommended.

Key words: Airway edema, airway complications, postoperative, tracheal edema.

Introduction

Airway management is a common issue in the intensive care unit, with significant morbidity and mortality. It is

estimated that one-third of airway complications occur upon extubation, yet studies and guidelines are lacking in this area. (1) Previously published risk factors for development of postoperative airway complications include age ≥ 70 years, obesity with weight ≥ 90 kg, operative time > 10 hours, operations on the neck, and transfusion of blood > 4 units. (2-4) The majority of these patients have prolonged intubation times due to upper airway edema.

Published strategies to reduce airway edema have focused primarily on steroid administration. Prophylactic administration of steroids has been shown to reduce the incidence of perioperative laryngeal edema and reintubation. (5) However, post-extubation airway complications are not only due to laryngeal edema, but they can also be

From Department of Surgery, Division of Trauma & Critical Care, Winthrop University Hospital, Mineola, NY, USA (Jonas P. DeMuro, Michael N. Mongelli, and Adel F. Hanna).

Address for correspondence:

Jonas P. DeMuro, MD, FACS
Attending Surgeon & Intensivist
Department of Surgery, Division of Trauma & Critical Care
Winthrop University Hospital
259 First Street, Mineola NY, 11501, USA
Tel: 516.663.8700
Fax: 516.663.8707
Email: jdemuro@winthrop.org

from laryngospasm, local compression of the airway due to hematoma, loss of pharyngeal patency, upper airway edema, and vocal cord paralysis. (1) Due to the presence of the endotracheal tube postoperatively, a laryngoscopy to assess the vocal cords and airway edema is not useful in this setting. Given the limitations of an exact diagnosis, a multimodal protocolized strategy is a reasonable solution.

We studied patients after surgical procedures who developed airway edema, which prevented their prompt and safe extubation postoperatively. We analyzed risk factors for the development of upper airway edema, and devised a practical strategy for the optimal management of such patients.

Materials and Methods

We retrospectively analyzed all Surgical Intensive Care Unit (SICU) admissions during a 24-month period from January 1st, 2009 to December 31st, 2011. Winthrop University Hospital is a 591-bed tertiary care facility, and a regional trauma center. It cares for over 20,000 operations annually, with a SICU volume of over 900 patients annually. Inclusion into the study required all of the following: age over 18-year-old that remained intubated at the conclusion of their operative procedure, a negative cuff leak test immediately postoperatively as described by Miller & Cole to ascertain for airway edema (quantification of <110 mL of tidal volume loss with endotracheal cuff deflated), (6) as well as failure to extubate while on mechanical ventilation for more than 24 hours postoperatively. All endotracheal tubes in the SICU have their cuff pressures measured twice daily, to keep the pressures between 15 mmHg and than 20 mmHg. This study was approved by our institution's Investigational Review Board.

The following management strategies were implemented to maximize the reduction of postoperative airway edema, and allow for expeditious extubation (**Table 1**). The protocol includes diuretics to induce negative fluid balance, corticosteroids to reduce airway inflammation, and head of bed elevation targeted at 45° to reduce neck edema and airway soft tissue swelling. Serial daily cuff leak tests were performed to identify readiness for extubation. A team consisting of anesthesia, an intensivist and a surgeon were assembled at the bedside for the extubation when criteria were met. They had advanced airway equipment, including

a tracheostomy tray and a GlideScope video laryngoscope (Verathon Medical, Bothell, WA).

Multiple variables were examined retrospectively, including age, gender, body mass index (BMI), perioperative fluid balance and use of intraoperative blood products, size of endotracheal tube, duration of mechanical ventilation, type and location of the surgery, and operative time. The dosage of steroids and diuretics used in our patients was also collected.

Results

Six female patients with postoperative upper airway edema were identified for inclusion into this study. The mean age was 54.5 years (range 33 to 73 years). The majority of procedures were performed on body regions other than the neck (**Table 2**). One of our patients had a history of bronchial asthma who underwent an anterior cervical discectomy without clinical exacerbation of her asthma. The average body mass index (BMI) was 34.8 (range 21.7 to 52.1). The mean operative time was 282.5 minutes (range 52 to 521 minutes). All patients had a positive operative fluid balance on admission to the SICU, with a mean of +5.0 L (range of 1.6 to 10.2 L). Two-thirds (66.7%) of our patients received an intraoperative transfusion of either packed red blood cells, fresh frozen plasma, and/or platelets, with an average of 17.3 (\pm 2.8) units intraoperatively.

Corticosteroids used were hydrocortisone, dexamethasone, and methylprednisolone, however each individual patient received a single agent. The total steroid dosage was then calculated for each patient and converted to a hydrocortisone equivalent dosage for uniformity. The resultant average dosage was 389.9 \pm 143.2 mg of hydrocortisone equivalents per day. We similarly used the same approach for diuretic use; our patients received both furosemide and bumetanide, which were converted into furosemide equivalent dose for uniformity as well. The average daily dosage equivalent was 63.0 \pm 28.8 mg of furosemide equivalents per day. Aggressive diuresis resulted in a loss of 2.87 \pm 3.07 L in the first 72 hours postoperatively, achieving a negative fluid balance in all six patients.

The median endotracheal tube size was 7 mm (range 6-7.5 mm). The average duration of mechanical ventilation was

71.3±35.9 hours. All patients were successfully liberated from mechanical ventilation, without any reintubations or emergent tracheostomies.

Discussion

Our series shows a predominance of female patients. This finding may be explained by anatomical gender differences, such as the shorter and narrower female trachea compared to males. Previous data has also reported a larger mean tracheal diameter in males compared to females. (7) In addition, the tracheal mucous membrane in females seems to be thinner and less resistant to trauma than that of their male counterparts. (8) This smaller tracheal width found in females, contributes to a greater tube to trachea ratio, which may predispose females to tracheal mucous membrane injury. (9) These anatomical gender differences are correlated by the higher incidence of female tracheal edema after extubation in a previous study. (10)

It was previously reported that neck surgery was a risk factor for postoperative airway edema. (2) In our series, one-third of our patients had neck surgery, however, the majority of patients had surgery on other anatomical sites (**Figure 1**). Although neck surgery remains a risk factor in our patients, we observed the airway edema occurring even without direct operative trauma.

Previous study has reported that greater than 10 hours of operative time was associated with upper airway edema. (4) In our series, our mean operative time was 282 minutes, and the longest case was 521 minutes, showing this issue can occur with shorter operative times. Longer operative times can result in increasing operative fluid administration, which contributes to the upper airway edema.

In addition, previous study has shown that obesity puts the patient at risk for postoperative respiratory complications. (2,4) Fifty percent of our patients were obese. We also found a significant correlation using a regression analysis between increasing BMI, and duration of intubation, which contributes to an increasing ICU length of stay (**Figure 2**).

Asthma has been previously identified as a risk factor in airway complications following anterior cervical surgery in one series. (4) However, our series identified only one patient that had a history of mild asthma who underwent an anterior cervical discectomy. The airway issue in this patient was due to local neck surgery and the positive fluid balance, and there was no exacerbation of her asthma.

Our study is clearly limited by the following factors: small sample size, incomplete data on preoperative airway assessment (Mallipati score), retrospective and nonrandomized design. Clearly, a larger prospective trial will be needed to validate our interventions, and the risk factors suggested by the limited data set.

Conclusion

Postoperative airway edema remains a challenge for intensivists. The risk factors in our series for upper airway edema include BMI, intraoperative fluid administration, blood products transfused and female gender. While neck surgery also remains a risk factor, the majority of patients in our series identified with the upper airway edema had thoracic or abdominal surgery. Previous research has focused on weight as a risk factor for delayed extubation, while BMI may be more descriptive of the body habitus for an unfavorable airway. Perioperative blood products transfused may contribute to upper airway edema, however the total perioperative fluid balance, may be more significant than just the number of blood products transfused.

Our management strategy for the patient with postoperative upper airway edema uses a multimodal approach of negative fluid balance, promotion of head and neck drainage by elevation of the head of bed, corticosteroid use, and the daily assessment for a positive quantified leak test. From our experience, this can be a successful strategy to deal with this patient population. With the inherent risks of an extubation complication, we advocate further study of a protocolized airway assessment in postoperative patients in a randomized fashion for validation.

Table 1. Postoperative upper airway edema management

- Head of bed elevation 45°
- Daily endotracheal tube leak test
- Diuretics for negative fluid balance (furosemide 20 mg or bumetamide 1 mg IV)
- Steroids (dexamethasone 10 mg IV loading dose, then 6 mg q6h for 72 hours, or methylprednisolone 40 mg q8h for 72 hours)
- Anesthesiologist and surgeon present in the unit at the bedside with difficult airway supplies including tracheostomy tray

Legend: The intensivist could choose the diuretic(s), and the steroid(s) administered.

Table 2. Summary of study patients

Patient number	Age (years)	Duration of mechanical ventilation (hours)	Operation	Body Mass Index (BMI)	Duration of surgery (minutes)	Intraoperative fluid administration (liters)	Postoperative fluid balance over 72 hours (liters)	Blood products (total units)	Mean daily dose of steroids (hydrocortisone equivalents in mg)	Mean daily dose of diuretics (furosemide equivalents in mg)
1	58	119.5	Anterior cervical discectomy	52.1	169	1.6	-3.1	0	462	73
2	55	43.0	Bilateral breast augmentation	21.7	279	5.1	-3	32	600	80
3	54	39.0	Thoracic spine stabilization	25.0	521	5.6	-1.6	2	267	30
4	73	111.0	Fusion T10 pelvis	35.7	301	10.2	-0.7	13	195	48
5	54	44.5	Parathyroidectomy	29.4	373	2.8	-0.1	0	400	40
6	33	71.0	C-section	44.6	52	4.5	-8.6	22	392	107
Average	54.5	71.3		34.8	282.5	5.0	-2.9	11.5	386	63

Figure 1. Pie chart of the anatomical regions of the surgeries of the study patients

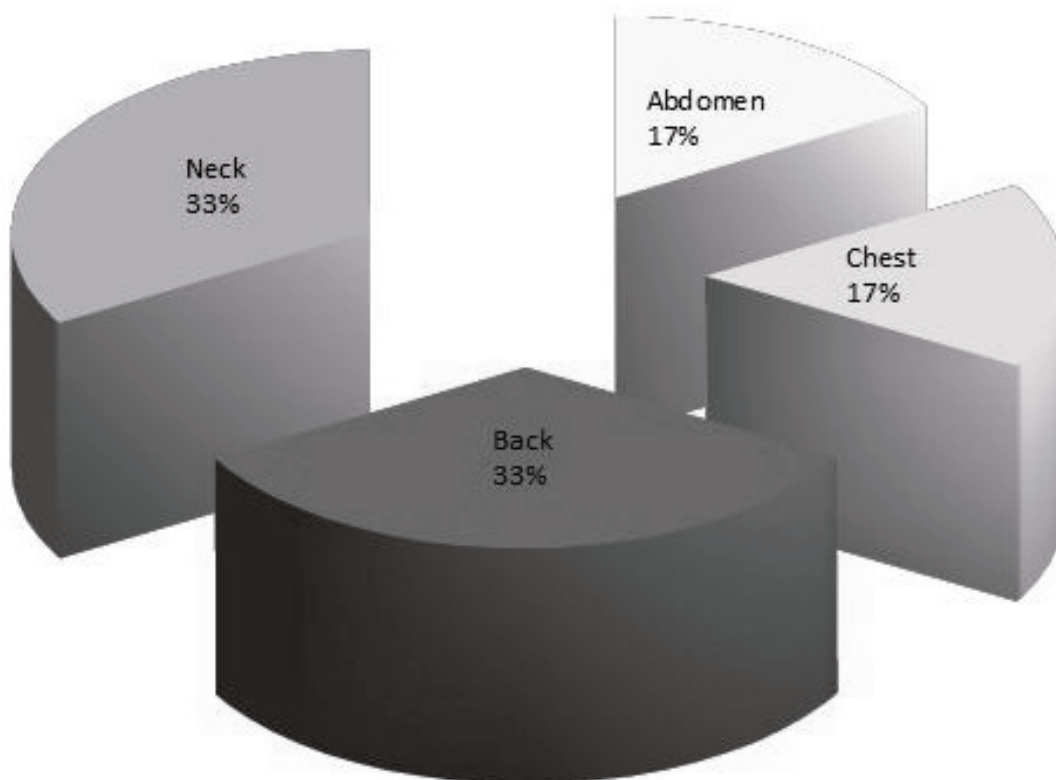
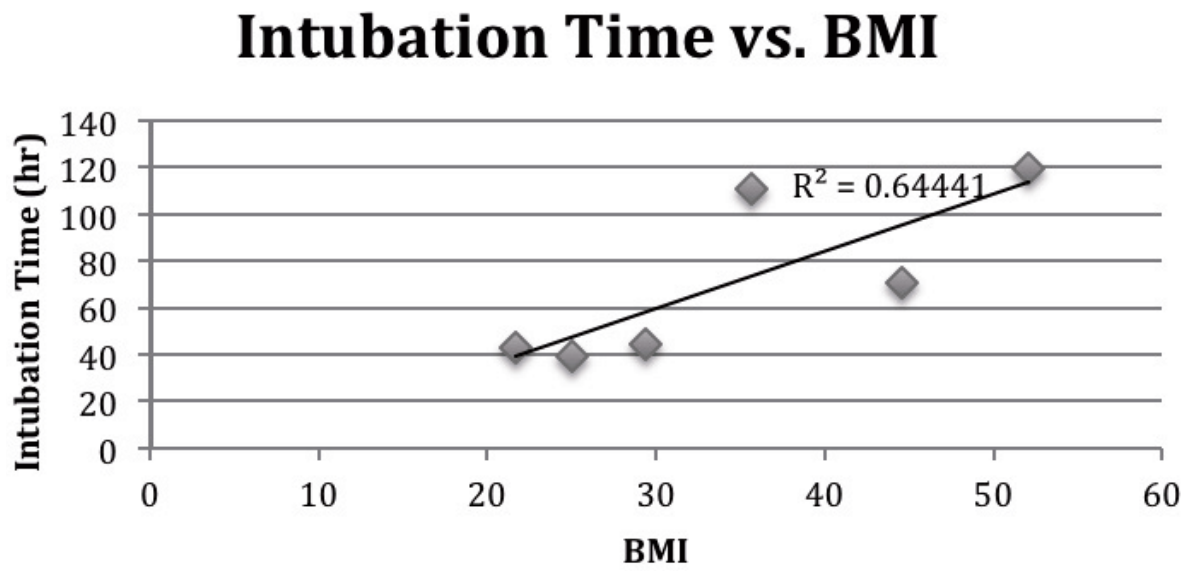


Figure 2. Plot showing the trend towards higher BMIs associated with longer intubation times



Legend: BMI=body mass index.

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