CAS 2024
Airway Management Abstracts

Contents

Three-dimensional printed model to assist intubation in a patient with fibrous dysplasia: a case report

Submission ID

54

AUTHORS

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INTRODUCTION

Three-dimensional (3D) printing has many applications in perioperative environments, including surgical reconstruction, bronchial stenting, and training phantoms for ultrasound-guided neuraxial blocks, and recently in the management of difficult airways. Fibrous dysplasia is a benign skeletal condition and a genetic mutation that replaces normal bone with abnormal fibro-osseous tissue. It affects either one bone (monostotic) or multiple bones (polyostotic),[1] such as the long bones, ribs, craniofacial bones, and pelvis.[2] We present the application of a 3D-printed model to support the anesthesia and surgical planning processes of a patient with a predicted difficult airway secondary to severe temporomandibular joint fibrous dysplasia.

CASE PRESENTATION

A 58-yr-old lady with fibrous dysplasia presented with left hemifacial hypertrophy, requiring multiple previous osteotomies. Her symptoms recurred, and she presented with dysmorphia secondary to profound swelling of the left side of the face and severe restriction of mouth opening, which prevented her from eating solid food and subsequently resulted in significant weight loss. She was scheduled for a left condylotomy and fat graft insertion.

During the preanesthetic evaluation, we predicted difficulty in intubation and bag mask ventilation. Prior to surgery, we analyzed the 3D printed model of her skull and face, modelled off computed tomography (CT) scans taken for operative planning, and ascertained that except for her challenging 7-mm mouth opening, there was no obstruction internally and that her upper airway was otherwise patent.

Her nasal airway was confirmed to be patent posttopicalization and fibreoptic scope insertion. The upper airway was topicalized using nasal co-phenylcaine, 2% lignocaine for the laryngophargnx, and a transtracheal local anesthetic injection. The first attempt at intubation was unsuccessful because copious secretions obstructed the view and the endotracheal tube (ETT) inadvertently slipped into the oesophagus during the adjustment of the tube postintubation. The second attempt at intubation was successful, and a #6.0 ivory nasal ETT was inserted. The patient's mouth opening improved postsurgery, and the patient was

extubated uneventfully at the end of surgery and did not require reintubation. If a 3D-printed model was not available, we might have elected for the invasive approach of tracheostomy under local anesthesia because of the possibility of significant airway obstruction posteriorly.

CONCLUSION

Anesthesiologists continue to encounter significant challenges because of difficult airway, especially when faced with uncommon clinical situations such as fibrous dysplasia. There have been other case reports of the use of 3D technology, including the use of a 3D model to facilitate intubation,[3] to simulate tracheostomy, bronchoscopy and lung isolation.[4] As shown in our patient, the use of 3D technology to assist in the planning and execution of intubation in a patient with distorted anatomy is a helpful addition to a thorough airway examination when planning intubation and it avoided the need for invasive airway management techniques.

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Figure

Extubation forces generated by inflated *versus* deflated tracheal tube cuffs

Submission ID

100

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INTRODUCTION

Excessive forces during tracheal intubation or extubation can be associated with laryngeal trauma and lead to complications such as arytenoid dislocation, vocal cord damage, or laryngotracheal stenosis.[1] Conflicting strategies regarding management of the tracheal tube cuff at extubation have been proposed in the literature. In contrast to the conventional technique of complete cuff deflation before extubation, some advocate removal of the tracheal tube with the cuff fully inflated to reduce the risk of aspiration and atelectasis.[2,3] Another strategy is "snapping" or breakage of the pilot cuff tubing just before extubation, which allows for partial cuff deflation. Theoretically, a partially deflated cuff will carry secretions out of the glottis, while not causing excessive extraction forces. The purpose of this study was to compare the forces exerted on the glottis during extubation for three tracheal tube cuff conditions; cuff fully inflated, partially deflated, and fully deflated.

METHODS

This benchtop equipment study did not require research ethics review. A custom-built testing fixture was designed for this study. The test fixture included a low friction roller bed which was attached to an inline load cell (BTE 50N digital force gauge) and a plastic larynx model (Laerdal Airway Model, p/n 252500) which was rigidly attached to the roller bed. Testing was done using 7.5 mm ID Shiley Hi-Lo cuffed tracheal tubes (Covidien). The cuffs were lubricated with 0.5 mL of water-soluble lubricating gel before each test. For each test the tracheal tube was manually extracted at a rate consistent with clinical use. Twenty trials were performed for each of the three different cuff conditions; fully deflated, fully inflated (cuff pressure set to 30 cm H_2O using a manometer), and pilot tubing snapped immediately before extubation (within one to two seconds). To assess for narrowing after pilot cuff tubing breakage, the outer diameter of the tubing was measured using digital calipers (Mastercraft, 58-6800-4) at the breakage point and 5 cm distal to the fracture point. Peak extraction force data was analyzed using analysis of variance with the Holm–Sidek correction. Pilot tube diameter data was analysed using a paired *t* test and linear regression.

RESULTS

Extubation with the cuff fully inflated resulted in significantly higher peak extraction forces both the fully deflated (mean force 5.93N *vs* 3.49N; $P < 0.001$) or partially deflated conditions (mean force 3.92 N; $P < 0.001$; Figure). Partially deflated cuffs did cause marginally higher extraction forces than fully deflated, but this was not statistically significant ($P = 0.19$). In the group where the pilot tube was snapped, the diameter of the pilot cuff tubing was significantly reduced at the breakage point (diameter reduction range 4.4% to 15.4%; $P < 0.001$), and the reduction in diameter significantly correlated with increased extubation forces ($R^2 = 0.241$, slope, $P = 0.028$).

DISCUSSION

Previous research has shown that stylet extraction forces exceeding 10N at the time of intubation were associated with increased risk of postoperative sore throat.[4] None of the extubation cuff strategies tested in this study were above this threshold. We also observed that breakage of the pilot tubing consistently caused narrowing of the tubing diameter, which is relevant as cases of complete pilot obstruction and extubation difficulties have been described with this technique.[5] A limitation of this study is the use of a plastic model with a fixed glottic aperture, which does not account for vocal cord adduction forces.

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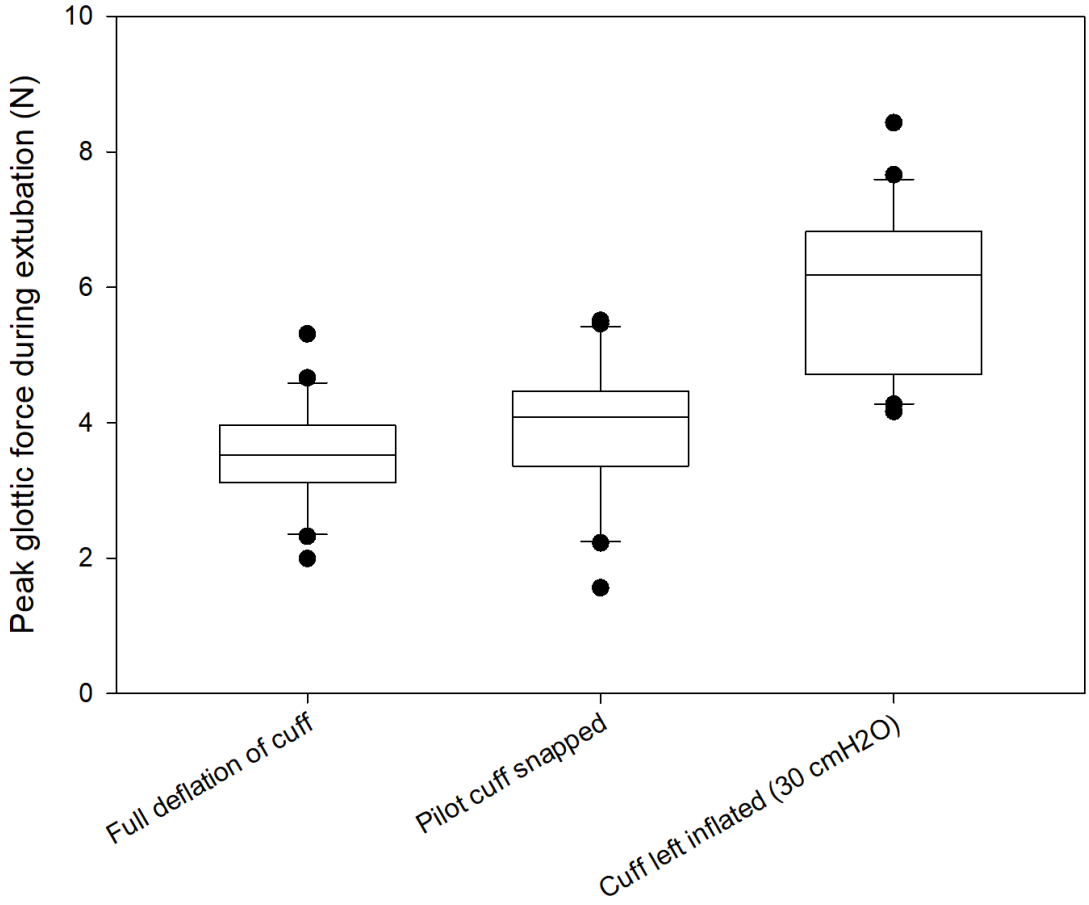
Figure


Peak glottic force during extubation (N)
10
8
6
4
2
0
Full deflation of cuff
Pilot cuff snapped
Cuff left inflated (30 cmH2O)

Patterns of sugammadex usage for intraoperative muscle relaxant reversal at a Canadian academic teaching centre: a 70-month study

Submission ID

106

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INTRODUCTION

Sugammadex is a selective binding agent used as an alternative to Neostigmine in the reversal of the nondepolarizing muscle relaxants (NDMR). The rapid onset of this drug makes its use appealing in many airway management scenarios including general anesthesia, emergency medicine, and critical care. Some studies have shown improved outcomes for surgical patients treated with Sugammadex in terms of reduced postoperative respiratory complications.[1] Others have failed to detect any differences in respiratory outcomes after a complete changeover from Neostigmine to Sugammadex.[2] Current national guidelines recommend the use of Sugammadex for reversal of deep neuromuscular motor blockade;[3,4] however, concerns have been raised regarding the cost of this drug and indication creep, particularly in terms of widespread usage because of unrestricted access. The purpose of this study was to characterize the patterns of NDMR reversal before and after the availability of Sugammadex in the operating rooms at our academic teaching institution.

METHODS

Institutional research ethics approval was granted for this retrospective database study. Our electronic anesthesia information management system (Innovian, Dräger Medical) was searched between January 2016 and October 2021 for all adult surgical cases done under general anesthesia with tracheal intubation. The first 17 months of our study period captured muscle relaxant and reversal agent usage before Sugammadex was made available in our operating rooms (June 2017). Demographic data including patient sex, age, body mass index, and surgery category were collected along with the airway management details, type and dose of muscle relaxant (Rocuronium, Succinylcholine, Cisatracurium), and type and dose of muscle relaxant reversal agent (Neostigmine or Sugammadex). The data was collated in pivot tables and expressed using mean (SD) or median [IQR], and the monthly proportions of drug usage after the Sugammadex release date were analyzed using linear regression (Sigma Stat 12).

RESULTS

A total of 73,099 adult surgeries were analyzed over the entire 70-month study period. The cohort was 47.9% female, with mean age of 58 (± 17) yr. In the 17-month period before Sugammadex release, a total 18,847 cases were performed with Rocuronium administration in 93.7% of the cases. The mean proportion of cases where Rocuronium was reversed with Neostigmine in the pre-Sugammadex release period was 68.4% (± 2.1). After its release, Sugammadex use (Figure) significantly increased (slope, +0.51% per month; $P < 0.001$; $R^2 = 0.952$) while the rate of Neostigmine usage significantly decreased (slope, −0.23% per month; $P < 0.001$; $R^2 = 0.742$). The total proportion of cases reversed by either Neostigmine or Sugammadex also was found to significantly increase after Sugammadex release (slope, +0.277% per month; $P < 0.001$; $R^2 = 0.827$). The most common Sugammadex dose range was 101–200 mg (62.9%), followed by < 100 mg (18.8%) with only 2.3% of cases using doses of more than 400 mg.

DISCUSSION

Our study shows a gradual increase in the use of Sugammadex since its release in our operating rooms, with a corresponding decrease in Neostigmine use. The total percentage of cases reversed also increased, which may be reflective of increased Rocuronium usage and dosages secondary to the arrival of a convenient new reversal agent. This study is limited in that we did not capture neuromuscular monitoring use[5] or postoperative respiratory complications[1,2] associated with each reversal drug. We recognize that during the latter months of our study, waves of high COVID-19 infection rates impacted airway management techniques and neuromuscular blockade usage.

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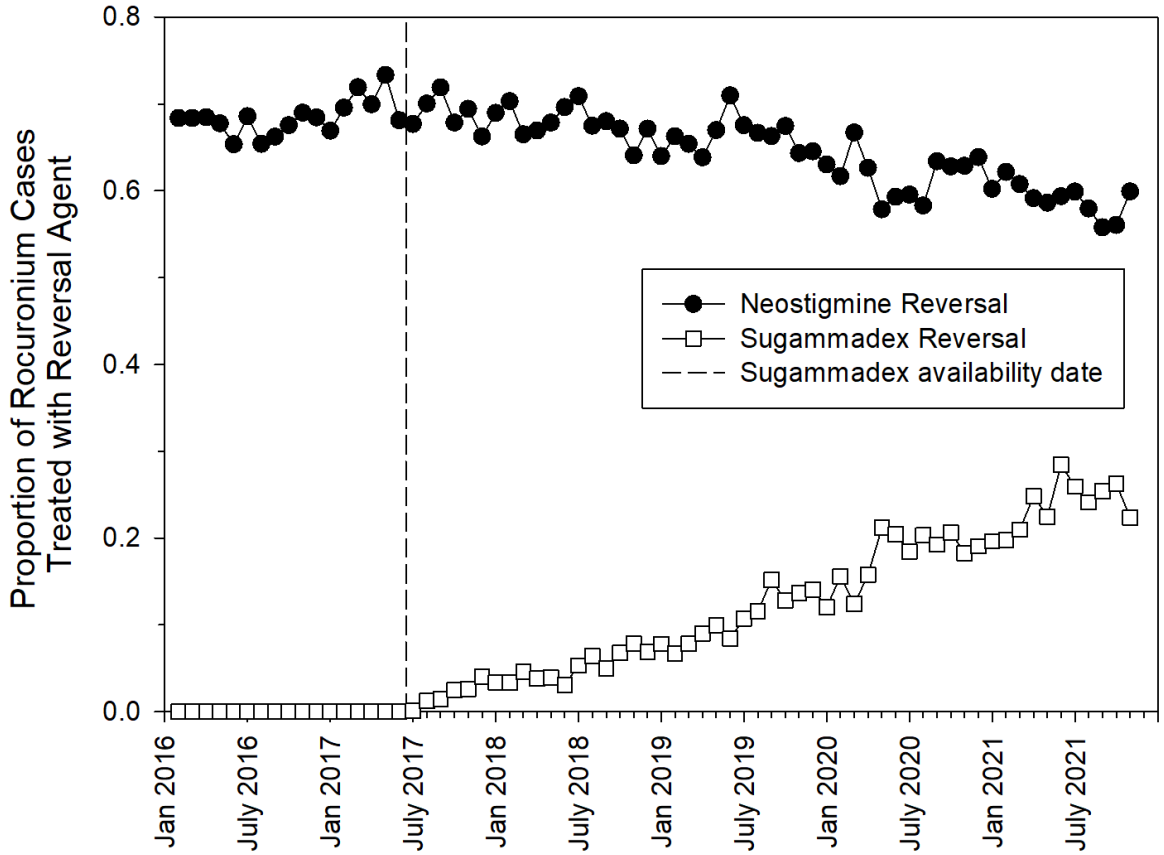
Figure


Proportion of Rocuronium Cases Treated with Reversal Agent
0.8
0.6
0.4
0.2
0.0
Neostigmine Reversal
Sugammadex Reversal
Sugammadex availability date
Jan 2016
July 2016
Jan 2017
July 2017
Jan 2018
July 2018
Jan 2019
July 2019
Jan 2020
July 2020
Jan 2021
July 2021

Postoperative lingual nerve injury following airway management: a literature review

Submission ID

14

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INTRODUCTION

The lingual nerve is the terminal branch of the mandibular division of the fifth cranial nerve. Postoperative lingual nerve injury is a rare but serious complication following airway management and can lead to significant discomfort and disability. Lingual nerve neurapraxia commonly presents as tongue numbness and altered taste in the anterior two-thirds of the tongue. This literature review explores the etiology, clinical presentation, management strategies, and potential preventive measures for lingual nerve injuries associated with airway management during surgery.

METHODS

A search of PubMed, Medline, EMBASE Science Direct, Cochrane library, and Web of Science databases was done since inception to 8 June 2023, including any observational studies and clinical trials describing patients diagnosed with lingual nerve injury following airway instrumentation. Covidence software was used for screening. Duplicate records were removed, and two independent reviewers screened records for relevance. From eligible studies, we extracted patient related perioperative variables such as age, American Society of Anesthesiologists Physical Status score, Mallampati score, and comorbid diagnoses. We also extracted the type of airway management done such as use of endotracheal tube, laryngeal mask airway (LMA), cuffed oropharyngeal airway, or laryngoscopy. Additionally, we retrieved data regarding postoperative outcomes such as presentation, time to onset and resolution of symptoms, investigations, and treatments.

RESULTS

We identified 40 studies that assess lingual nerve injury following intubation, including 35 case reports. Patients predominantly reported symptoms of loss of sensation in the anterior two thirds of the tongue or taste disturbances either hours after surgery or at most 24 hr after the operation. There was significant variability in the time until resolution of symptoms, ranging

between two hours and 19 months postoperation. Multiple risk factors for lingual nerve injury were identified. Anesthesia factors include difficulty with intubation and use of LMA. Surgical factors are long duration of operation and surgery of the head and neck. Patient factor includes female sex. No clear evidence regarding whether body mass index, Mallampati score, and age are risk factors of neuropraxia.

DISCUSSION

Our review highlights that lingual nerve injury is a prevalent consequence of airway management. To ensure that patients are fully informed about the risks associated with airway management, it is crucial to include lingual nerve neuropraxia as a potential complication that may arise. Anesthesiologists play a vital role in communicating these risks and providing reassurance in case of complications. Additionally, anesthesiologists should diligently address and control modifiable risk factors to mitigate the risk of lingual nerve injury.

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Spontaneous ventilation with laryngeal mask airway and bronchoscopy evaluation with bridge to extracorporeal membrane oxygenation during difficult tracheostomy for occluding tracheo-mediastinal thyroid neck mass: a case report

Submission ID

61

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INTRODUCTION

Invading neck masses with obstructing tracheal invasion and anterior mediastinal mass extension present potentially very difficult to impossible airway management and risk hemodynamic compromise. The Canadian Airway Focus Group recommendations suggest awake techniques in the predicted difficult tracheal intubation and difficult face-mask ventilation.[1] If this is not feasible, front of neck access is recommended. Nevertheless, in some cases, these options are not helpful. The use of supraglottic airways is also emphasized and may be used as a primary technique.[1] Veno-venous or veno-arterial extracorporeal membrane oxygenation (ECMO) has emerged as an advanced strategy to preserve oxygenation in these scenarios, and can be placed even in awake patients.[1–3] Here, we describe a case of difficult airway management decision-making through careful airway evaluation under anesthesia using a supraglottic airway (SGA) device followed by use of VV-ECMO to facilitate surgical airway access in a patient with locally advanced, metastatic, anaplastic thyroid cancer.

CASE PRESENTATION

A female in her 60s presents with acute stridor secondary to anaplastic thyroid cancer and a 7.5 cm × 6.0 cm anterior neck mass. Computed tomography scan revealed tracheal lumen invasion and displacement, mediastinal extension, abutting of pulmonary trunk, severe brachiocephalic vein compression, possible common carotid artery, and recurrent laryngeal nerve invasion. Her stridor improved with dexamethasone.

She was brought to the operating room (OR) and could only briefly lie flat but was hemodynamically stable. Front of neck access was not possible because of the large mass. Four percent lidocaine was nebulized while lower-extremity intravenous, right-radial arterial access was obtained and a bispectral index monitor applied.

Multidisciplinary planning was performed involving anesthesia, vascular surgery, perfusion, ENT, and thoracics. To assess the airway, inhalational induction with sevoflurane was gradually titrated ensuring maintenance of spontaneous breathing and patency. A size-4 Unique™ laryngeal mask airway (LMA) was placed with aperture bars removed. Low pressure-support ventilation to optimize tidal volumes was well-tolerated. Flexible bronchoscopy via LMA allowed vocal cords be sprayed with 2% lidocaine. Invasion in the proximal trachea confirmed distal intubation is impossible.

As planned, cannulation for VV-ECMO via right femoral and right IJ was performed. Although pressure of the neck could interrupt the airway; cannulation was effective. Total intravenous anesthesia was maintained with remifentanil, propofol and rocuronium. Surgical exploration confirmed unresectable tracheal invasion at rings 2–7. Partial thyroidectomy debulking, esophagogastroduodenoscopy and difficult tracheostomy were performed. Ventilation resumed through tracheostomy allowing ECMO to be weaned and decannulated in the OR. The patient recovered in the postanesthesia care unit and transferred to ENT step-down for further care, eventually discharged home.

CONCLUSION

Near-occlusive tracheal tumours with anterior neck and mediastinal involvement pose significant airway challenges. Multidisciplinary planning with careful approach of airway evaluation using spontaneous breathing and a supraglottic airway as a bridge to VV-ECMO where tracheal intubation or awake front of neck access is not possible can be an effective strategy.

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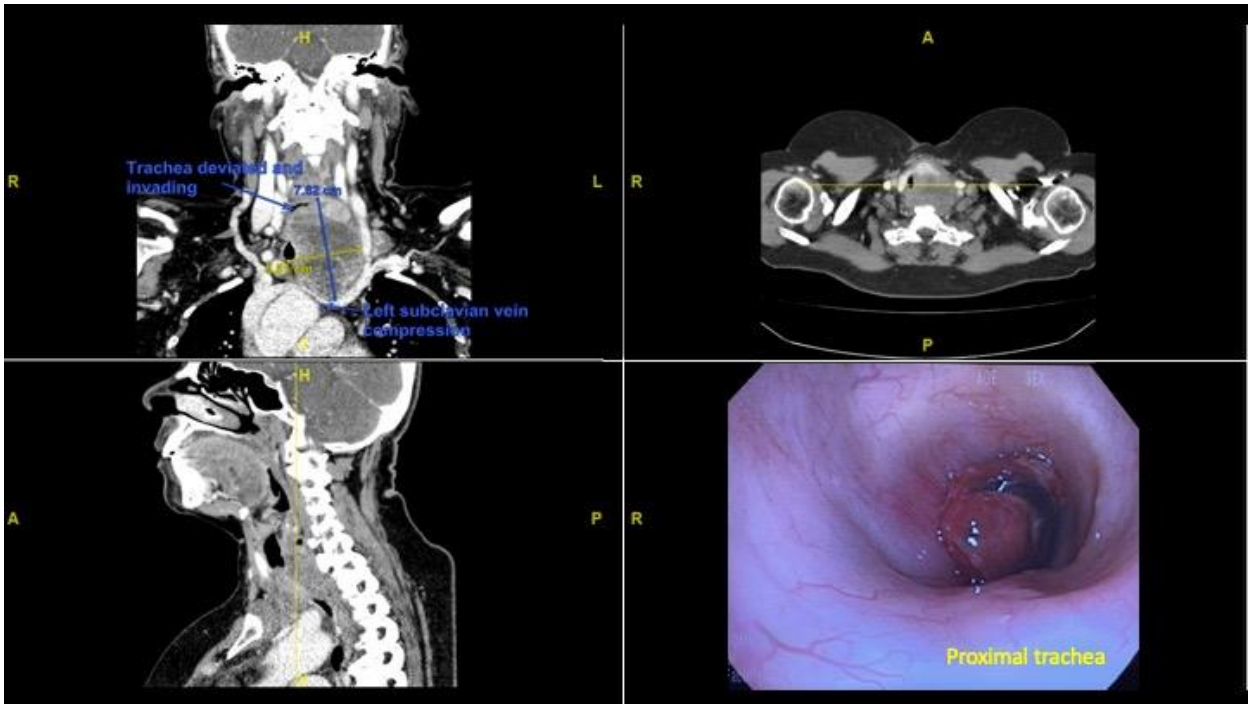
Figure


H
R
L
Trachea deviated and invading
7.82 cm
Left subclavian vein compression
A
P
H
A
P
A
R
Proximal trachea

Unwanted inflation from jet ventilation: a case report

Submission ID

45

AUTHORS

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INTRODUCTION

Idiopathic subglottic stenosis presents a complex clinical challenge, necessitating intricate airway management during surgical interventions.[1] Jet ventilation, a technique designed to enhance surgical access while minimizing vocal cord pressure, is frequently employed in such cases.[2,3] Nevertheless, its advantages are accompanied by the potential for barotrauma-related complications, including subcutaneous emphysema, pneumomediastinum, and, rarely, tension pneumothorax.[4] This case report highlights a unique instance of tension pneumothorax arising from transtracheal jet ventilation during endoscopic airway surgery. Contributing factors include catheter misplacement, high driving pressures causing hyperinflation, or outflow tract obstruction leading to gas trapping, with the latter identified as the most likely cause in this case.[5] Effective communication and meticulous planning between anesthesia and otolaryngology teams are pivotal, particularly in critical incidences that demand swift recognition and intervention. While jet ventilation stands as an efficient method, this report highlights possibilities of barotrauma-related complications, emphasizing timely recognition and management for optimal patient outcomes required in intricate airway scenarios.

CASE PRESENTATION

A 69-yr-old woman with idiopathic subglottic stenosis who previously underwent multiple interventions, including dilatations and laryngotracheoplasties, returned to hospital with acute dyspnea and stridor. Initial treatments with steroids, bronchodilators, and antibiotics proved ineffective. A neck computed tomography scan revealed restenosis of the subglottis, prompting further intervention. In the operating room, difficulties arose during visualization on suspension microlaryngoscopy because of poor neck extension, small mouth opening, anterior larynx, and the presence of an endotracheal tube. Ventilation became critically compromised, leading to attempts of ventilation using a small ventilating bougie, resulting in worsening oxygen saturation, airway bleeding, and subcutaneous emphysema. Despite re-intubation, respiratory

distress persisted with the oxygen saturation hovering around 80% and CO_2 return at 45 mm Hg, and subsequently, a tension pneumothorax was diagnosed and addressed promptly with a chest tube insertion. Following intensive care unit transfer, the patient exhibited barotrauma-related complications, including subcutaneous emphysema, pneumomediastinum, and pneumoperitoneum. Her condition gradually improved, transitioning to a tracheostomy collar and subsequent decannulation. The patient experienced stability for 15 months until symptoms recurred, leading to an awake tracheostomy and an uneventful recovery. The patient has remained stable for 18 months postoperatively. This case highlights the challenges in managing complex airway issues upon using jet ventilation, highlighting the importance of prompt recognition and appropriate interventions to address complications.

CONCLUSION

In conclusion, this case highlights the intricate balance required in employing jet ventilation for idiopathic subglottic stenosis. While the technique offers enhanced surgical access, the potential for rare but severe barotrauma-related complications demands consideration. The reported incident emphasizes the critical importance of being up to date with anesthesia guidelines, effective communication between specialties, and prompt recognition of evolving challenges. Successful resolution, marked by tracheostomy and chest tube insertion, attests to the significance of requiring prompt interventions in mitigating life-threatening complications. This case highlights the complexities inherent in managing complications such as pneumothorax, necessitating a multidisciplinary approach for optimal patient outcomes.

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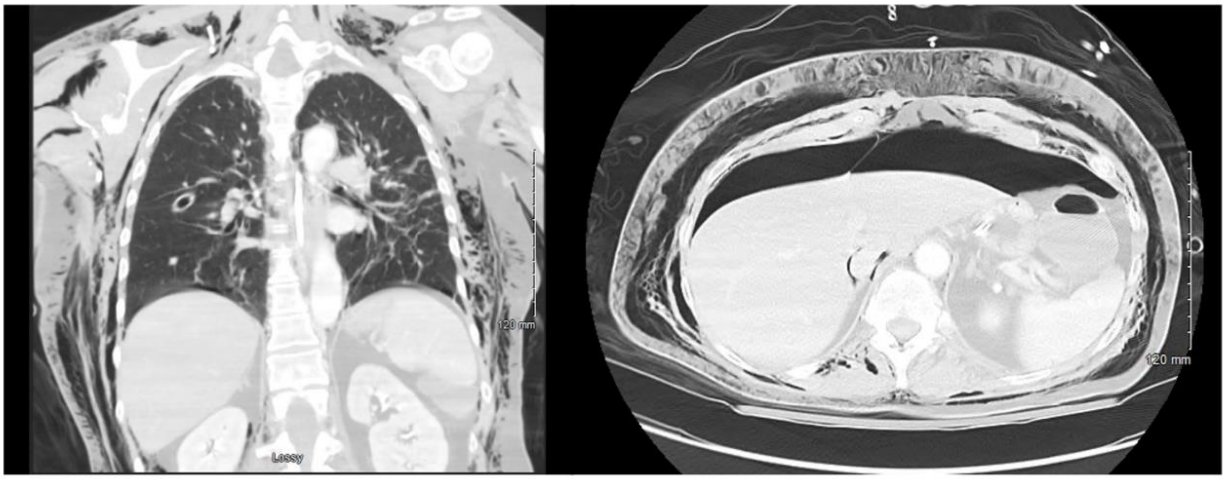
Figure Postoperative evidence of significant subcutaneous emphysema (A) and pneumoperitoneum (B)



Use of oscillometry to compare airway resistance and reactance in the supine, lateral, and prone positions

Submission ID

114

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INTRODUCTION

Oscillometry is a noninvasive technique to measure respiratory system impedance measuring resistance (R) and reactance (X) by superimposing small pressure waveforms during passive tidal breathing.[1] It can be used to detect heterogeneous obstruction attributed to the small airways relative to more central airways from the difference in resistance measured at 5Hz and 19Hz (R5-19). Oscillometry is more sensitive than pulmonary function testing for detecting peripheral airway obstruction.[2] This technique is useful for assessment of asthma, chronic obstructive pulmonary disease, interstitial lung disease,[1,2] intubation and mechanical ventilation,[3] and more recently the effects of supine[4] and lateral body positioning.[5] Oscillometry may thus be useful to assess improved lung ventilatory mechanics from prone positioning commonly used for some surgical procedures and the management of severe COVID-19. The purpose of this study was to compare respiratory impedance in the supine, lateral and prone positions using oscillometry.

METHODS

Thirty-five healthy volunteers were recruited after institutional research ethics approval and provided signed consent before study participation. Study exclusion criteria included recent respiratory infection, smoking history, pregnancy, uncontrolled asthma, or a history of other lung diseases. Self-reported height, weight, sex, and birth year were collected prior to testing. Oscillometry (tremoflo, Thorasys) was performed on a hospital stretcher starting in the supine position (S), followed by the left lateral (LL) and then the prone position (P). Prone positioning was based on the “swimmers” position used to prone ventilated intensive care patients, with bolsters under the chest and pelvis leaving the abdomen hanging free. The nostrils were sealed using a nose clip, and the cheeks were supported to prevent upper airway shunting. Three trials with a total respiratory resistance (R5) coefficient of variation less than 10% were collected in each position.[1] Resistance and reactance data (cm $H_2O \cdot L^{-1} \cdot s^{-1}$) at 5, 19, and 5–19 Hz, along with the resonant frequency (Fres, Hz) and area under the reactance curve (AX, cm $H_2O \cdot L^{-1}$) were

analyzed using repeated measures analysis of variance, with the Holm–Sidak or Tukey test for multiple comparisons.

RESULTS

The preliminary study cohort included 19 males and 16 females, with a median age of (31 yr [IQR, 27–33] and mean body mass index of 26.2 $kg \cdot m^{-2}$ (SD ± 3.0) for males and 22.3 (SD ± 1.8) for females. Significant differences in R5, R19, and R5–19, X5, Ax and Fres were seen for the different conditions (Table).

DISCUSSION

Increased small airway resistance (R5–19) and lower lung compliance (more negative X5, increased Fres) have been previously reported in nonobese patients comparing supine to lateral positioning.[5] Our findings confirm this, but we also found lower resistance in lateral compared with prone position. Additionally, X5 was different only for lateral to prone, indicating less lung stiffness when lateral, agreeing with higher AX and Fres for supine and prone positions. Together these data show improved respiratory mechanics when lateral compared with supine and prone, from less airflow obstruction involving the small airways and increased compliance in the lateral position.

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Table Resistance and reactance results (*n* = 35 subjects) reported as mean (SD) or median [IQR], along with the positions that demonstrated significant differences with pairwise comparisons

Variable (units)	Supine (S)	Lateral (LL)	Prone (P)	$p < 0.05$
R5 (cmH2O/L/s)	3.96 (1.19)	3.36 (0.97)	3.86 (1.17)	S vs LL, LL vs P
R19 (cmH2O/L/s)	3.41 [2.73-4.13]	2.93 [2.57-3.90]	3.24 [2.69-3.96]	S vs LL, S vs P
R5-19 (cmH2O/L/s)	0.34 [0.09-0.57]	0.23 [(-0.04)-0.42]	0.51 [0.23-0.71]	S vs LL, LL v P
X5 (cmH2O/L/s)	-1.25 [(-1.60)-(-0.96)]	-1.19 [(-1.46)-(-0.93)]	-1.28 [(-1.88)-(-1.02)]	LL vs P
AX (cmH2O/L)	4.31 [2.47-6.63]	3.19 [2.07-5.22]	4.87 [3.33-6.87]	S vs LL, LL vs P
Fres (Hz)	10.93 [9.77-12.44]	10.44 [9.69-12.22]	11.64 [10.52-13.88]	S vs LL, LL vs P