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Editorial
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Fiberoptic Bronchoscopy Complications

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Editorial

Fiber optic bronchoscopy as a tool for diagnosis, therapeutic, and palliative intervention in patients with pulmonary pathology was first described in 1967. Since its introduction, published rates of complications from fiber optic bronchoscopy have ranged from <0.1% to 11%, however mortality rates are low, estimated at less than 0.1%. Mechanical complications of bronchoscopy are primarily related to airway manipulations. Systemic complications arise from the procedure itself, medication administration primarily sedation, or patient comorbidities. These complications include respiratory failure, laryngospasm, bronchospasm, hemorrhage, atelectasis and pneumothorax [1]. Most complications occur during or in the first few hours following procedure. The likelihood of a complication is minimized by appropriate patient selection, careful evaluation of the risk-benefit ratio in high risk patients, and adherence to patient safety protocols.

Understanding of medications and management techniques that can decrease procedural risk or utilization of bronchoscopy techniques for rapid intervention of procedural related complications is critical for optimal patient management.

While complications rates are low, often these procedures are indicated in patients with limited pulmonary reserve. This article provides insight to the patient population at greatest risk for procedural complications during and following bronchoscopy. Utilizing interventions that can decrease procedural complications in an attempt to prevent complications is vital in all patients but especially those with limited pulmonary reserve such as COPD patients.

Bellinger et al. [2] prospectively looked at 258 patients over 12 months who underwent bronchoscopy under moderate sedation as an outpatient. Sixty-seven (44%) had COPD with 6 (9%) mild, 29 (42%) moderate, 27 (41%) severe and 5 (8%) very severe disease. Thirteen percent of the COPD patients had minor complications and five percent had severe complications. The severe and very severe COPD patients had significantly more complications than the patients without COPD. This study is prospective and well performed. The COPD patients were on inhalers but the authors did not check that each patient's treatment was optimum before the bronchoscopy. This is also a single center study. Identification of at risk patient populations for bronchoscopy allows one to anticipate, and prevented or reduced procedural complications in high risk patients. This study helps define those patients at greatest risk for procedural complications. The patients with severe and very severe COPD defined as forced vital capacity in 1 second (FEV_1) less that 50% (severe COPD) and less than 30% (very severe COPD) experienced the most procedural complications.

Interventions shown to reduce bronchoscopy procedural risk and treat procedural complications have been well described.

Sedation during bronchoscopy can precipitate hypoxic and hypercapnic respiratory failure. Ideal sedatives have rapid onset, short duration, and allow rapid recovery [3]. Benzodiazepines have sedative, hypnotic, anxiolytic and muscular relaxing effects. Midazolam has a rapid onset and short half-life and thus is the preferred benzodiazepine. This drug may depress the ventilatory drive in low doses and may cause apnea in large doses especially in patients with comorbidities and in those taking other respiratory depressant drugs. The elderly, obese, and those with renal or hepatic dysfunction are at greater risk of prolonged sedation. In such patients, the use of lower doses, longer dosing intervals, and smaller total amounts reduces risk.

Opioids have analgesic, antitussive, and sedative effects. Fentanyl is more potent that morphine and has a more rapid onset of action. Both morphine and fentanyl can be given in incremental doses. In high doses, may lead to bradycardia and hypotension. Remifentanil is a μ opioid receptor with analgesic potency similar to fentanyl. It has short half-life and is used in combination with propofol, however dosing is through continuous infusion. Propofol is a short acting anesthetic with hypnotic, antiemetic, and antipruritic effects. It can be given in bolus doses or continuous infusions. It is

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Table 1: Bronchoscopy.

	Bronchoscopy Complications	
Mechanical	Trauma	Oropharyngeal Nasopharyngeal Vocal Cords
	Bronchospasm	
	Laryngospasm	
	Atelectasis	
	Elevated Airway pressures	
	Hemorrhage	
	Infection	
Systemic	Procedure-related	Vasovagal syncope Nausea/Vomiting Aspiration Hypoxemia Hypercarbia
	Medication related	Sedation Non-sedative medication
	Comorbid illness	Myocardial dysfunction/Arrhythmia Pulmonary insufficiency Elevated Intracranial pressure Death

highly lipophilic and therefore crosses the blood-brain barrier rapidly. It has more rapid onset and short half-life than the benzodiazepines (takes effect within usually 40 seconds and its duration of action is approximately 6 minutes). However, the narrow therapeutic index between sedation and anesthesia often necessitate administration by an anesthesiologist. Fospropofolis a pro-drug of propofol with longer onset of action but shorter half-life. It does not cause pain with injection or have the risk of bacterial contamination that has been associated with propofol infusions. Dexmedetomidineis a selective alpha-2-agonist that has both sedative and analgesic properties. It has the advantage of causing only mild respiratory depression. However it can precipitate bradycardia and hypotension. Further, administration of Dexmedetomidineis is done via continuous infusion. Ketamine is Used in flexible bronchoscopy especially in children. It can cause tachycardia, hypertension, laryngospasm, increased intracranial and intraocular pressure, and hypersalivation (because of stimulation of sympathetic nervous system and inhibition of norepinephrine reuptake) [3].

Hypoxemia is a common occurrence during bronchoscopy. The PaO_2 decreases approximately 20 mmHg with the most significant drops occurring during bronchoalveolar lavage (Table 1). A retrospective study on 164 patients who underwent a bronchoalveolar lavage (BAL) while on mechanical ventilation found that procedure-related hypoxia (peripheral oxygen saturation ≤ 88 percent) in 9 percent of patients, and a decrease of >25 percent in the partial pressure of oxygen/fraction of inspired oxygen (PaO_2/FiO_2) ratio was found in 29 percent of patients [4]. Oxygen is routinely administered during bronchoscopy. Various interfaces have been utilized to ensure adequate SpO_2 is maintained during the procedure. High flow nasal cannula has been increasingly utilized in patients with hypoxic respiratory failure. Recently utilization of these cannulas and heated/humidification circuits were investigated for use during bronchoscopy. Lucangelo et al. [5] further investigated the role of HFNC during bronchoscopy. Patients were randomly assigned to three study groups, using Venturi mask or high flow nasal cannula. In one group, flows were 40 L/min with FiO_2 0.5 utilizing Venturi mask, another group with similar flows and FiO_2 (40 L/min and 0.5 respectively) but using HFNC instead. The third study group received HFNC at higher flows 60 L/min and similar FiO_2 of 0.5. The third group utilizing HFNC at 60 L/min and FiO_2 0.5 was shown to result in higher PaO_2, SpO_2 and lower heart rates than those patients managed with either the Venturi Mask or HFNC at lower flow rates. Respiratory and cardiovascular variables did not differ significantly between the Venturi Mask and HFNC 40 L/min group. Thus, HFNC represent a tool that can be utilized in patients with marginal oxygenation pre-procedure.

Laryngospasm is the sustained closure of vocal cordsresulting in the partial or complete loss of the patient's airway which can rapidly lead to hypoxemia and bradycardia. It is a protective primitive airway reflex that prevents against aspiration of material into the airway. Laryngospasm can be triggered by direct laryngeal or distant stimulation. Patients with asthma, smoking, younger age, recent URI, sleep apnea, and GERD all have been associated with increased risk of laryngospasm [6]. The overall incidence has been reported by Olsson and Hallen at just under 1% however more commonly in children than adults. Recognition of at-risk patients will help to prevent laryngospasm and avoid potential significant morbidity. Tracheal extubation during forced positive pressure inflation decreases laryngeal adductor excitability, decreasing the likelihood of laryngospasm, and also clears the airway of secretions or blood. Pharmacological prevention of laryngospasm has been reported. Magnesium (15 mg/kg) administered IV has been shown to reduce frequency of laryngospasm after awake extubation. Topical lidocaine applied to the larynx before airway manipulation has also been shown to prevent laryngospasm. Topical anesthesia also helps blunt the cough reflex. Two percent viscous lidocaine topical, 4% or 10% lidocaine spray or nebulizations are the most common means of administration. Higher concentrations of lidocaine provide quicker and deeper blockage [3]. Risk of toxicity is increased in elderly patients, patients with cardiac or liver disease, or patients taking beta-blockers, cimetidine, or verapamil.

Goudra et al. [7] found that higher doses of the short acting opioid remifentanil (0.3 μg/kg/min to 0.5 μg/kg/min) used in conjunction with propofol was shown to be superior in decreasing risk of cough and laryngospasm in patients undergoing bronchoscopy. The sedation in this study was managed by anesthesia and ventilation was achieved via laryngeal mask airway.

Anesthesia of the larynx and trachea can also be accomplished using nerve blocks. Several highly effective regional anesthesia techniques can help blunt gag and cough reflexes. Innervation of the oropharynx, tongue, epiglottis and distal airways occurs via the glossopharyngeal and vagus nerve. The glossopharyngeal nerve can be anesthetized via intraoral or extraoral approaches. The superior laryngeal branch of the vagus nerve innervates the base of the tongue, posterior surface of the epiglottis, aryepiglotic fold, and arytenoids. Extraoral blockage can be accomplished using landmarks of the larynx. The recurrent laryngeal nerveprovides innervations to the vocal folds and trachea. This can be effectively blocked via a trans-tracheal block approach [8].

Bronchoscopy in patients with known bronchial hyper-responsiveness has been investigated. Rankin et al. [9] reported that pre-treatment with intravenous aminophylline prior to bronchoscopy prevented significant bronchospasm in patients with mild asthma. Routine administration of inhaled bronchodilators prior to flexible bronchoscopy has been recommended in patients with asthma [10]. Asthma patients who undergo bronchial thermoplasty are given

prednisone prior to, day of, and after the procedure to reduce risk of procedure related asthma exacerbation [11]. However, pre-procedure bronchodilator treatment in COPD patients did not prevent decline in post-procedure FEV_1. An important observation in one study was that patients with higher GOLD stage classification experienced more significant decline in the post-bronchoscopy FEV_1 and thus warrant close observation pre and post-procedure [12].

Bronchoscopy associated bleeding complications occur infrequently. Most bleeding events are minor and resolve spontaneously with natural hemostasis. In a retrospective study of more than 4,000 bronchoscopies, transbronchial biopsy was associated with a bleeding rate of 2.8 percent [13]. However, almost all of the bleeding events resolved with conservative measures. Thus, most minor bleeding events are generally treated expectantly. In a registry-based study using the American College of Chest Physicians Quality Improvement Registry, Evaluation, and Education (AQuIRE) database, the rate of bleeding was significantly lower at less than 1 percent in patients who underwent transbronchial biopsy using endobronchial guidance [14]. The risk of bleeding during transbronchial biopsy appears to be significantly high in patients receiving antiplatelet therapy, with bleeding rates of 89% (16 of 18 patients) for clopidogrel alone and 100% (12 of 12 patients) for clopidogrel plus aspirin, according to a prospective cohort study of 604 patientsperformed by Ernst et al. [15]. The risk of bleeding can be minimized by avoiding transbronchial biopsy in patients who have an uncorrected coagulopathy and thrombocytopenia (≤ 50,000/mm^3), patients who have recently taken antiplatelet medications, and patients with lesions that are likely to bleed (e.g., vascular tumors, pulmonary hypertension). For those in whom bleeding continues, ice cold saline and/or epinephrine can be sprayed on to the bleeding lesion. Ensuring availability of armamentarium to intervene in cases where the bleeding dose not abate on its own is important [13].

Protecting the non-bleeding lung is vital and can be accomplished by positioning the patient such that the bleeding lung is in the dependent position. Wedging the bronchoscope in the segment/sub-segment that is bleeding and instilling iced saline or thrombin (5,000 Units dissolved in saline) can facilitate homeostasis [16,17]. Instilling Lidocaine/epinephrine or saline/epinephrine (1:1,000 epinephrine) mixture can induce local vasoconstriction and also facilitate homeostasis [18]. At our institution, pre-treatment with 2 ml to 3 ml of epinephrine mixture prior to biopsy has resulted in reduced procedure related bleeding following transbronchial biopsies (Unpublished data). Factor VII and tranexamic acid instilled through the bronchoscope have also been utilized for post-procedure bleeding complications [13]. Serious life-threatening bleeding that fails these conservative measures may be treated with several options including local ablative therapies such as argon plasma coagulation, embolization, or surgery; the choice among these options depends on the source of bleeding, availability, or local expertise.

Pneumothorax or pneumomediastinum following transbronchial biopsy is well described with rate of approximately 4 percent in a retrospective study of more than 4,000 bronchoscopies [13]. Most cases are minor with tension pneumothorax being rare. Risk of pneumothorax varies depending on the site of biopsy. It is not clear whether imaging or navigational guidance reduces this rate. However, in a registry-based study using the American College of Chest Physicians Quality Improvement Registry, Evaluation, and Education (AQuIRE) database, reported a pneumothorax rate of less than 2% in patients who had a diagnostic biopsy for peripheral lung lesions, some of whom had navigational guidance [19]. The same registry reported a pneumothorax rate of 3 percent when EBUS-guided procedures were performed [14]. Using fluorography to guide biopsy instrument placement pneumothorax risk is estimated at less than 1% to 2% [20]. Pneumothorax can also rarely occur from bronchoscopy alone (without an associated interventional procedure) when performed during mechanical ventilation, presumably from increased airway pressure. While most cases occur within minutes or hours after the intervention and are detected on routine chest radiography following bronchoscopy, some cases are delayed and can occur up to 24 hours later. Post-procedure ultra sound of the chest with M-Mode analysis of the pleura can help to rapidly identify iatrogenic pneumothorax complications and facilitate intervention prior to patient clinical deterioration. Many cases are managed conservatively while the reminder require drainage of air, often with a chest tube. In a large retrospective study less than half of patients with transbronchial biopsy-associated pneumothorax required a chest tube [13]. It is rare that patients who develop pneumomediastinum have thoracostomy tubes placed but they should be monitored radiographically.

Argon plasma coagulation (APC) is an electrosurgical, noncontact thermal ablation technique that uses argon gas to generate heat, which, in turn, can be used to resect tissue and/or to achieve hemostasis. It is an immediate-acting therapy used to relieve/palliate symptomatic central airway obstruction (CAO) due to malignant or benign conditions. Complications of bronchoscopic APC are infrequent but range from 0.5 to 4 percent. The most common APC-related complications are airway fire/burns and airway perforation resulting in pneumomediastinum, subcutaneous emphysema, pneumothorax, and fistula formation. Additional complications include gas embolism, melting of stents or endobronchial tubes, severe hemorrhage, electrical shock, and burning of equipment. Gas may enter through the bronchial veins (bronchial lesions) to result in left heart gas embolism or through systemic veins (tracheal lesions) to result in right heart gas embolism [21,22]. APC does not appear to increase the risk of bacteremia compared to airway insertion of the bronchoscope. Although contamination of the APC catheter with oropharyngeal commensal bacteria is common, clinically significant infection following the APC procedure is rare [23].

Airway fires can theoretically be minimized by avoiding high-flow oxygen during APC firing, limiting the applied power, and reducing the application time. In addition, keeping the probe tip several centimeters away from any combustible material, such as an endotracheal (ET) tube, a nonmetallic stent, or a covered metallic stent, may minimize this risk. Colt and Crawford [24] have reported that the risk of igniting or melting nonmetallic stents (such as silicone) or covered metallic stents may be limited by keeping the power at 40 watts or less, the fraction of inspired oxygen at 0.21 or lower, and the argon flow rate at less than 0.8 L/min.

Electrocautery is a bronchoscopic technique that is used to treat benign or malignant airway lesions that are endobronchial and involve the central airways. Treatment may be curative or palliative. Endobronchial electrocautery usually well tolerated and results in minimal morbidity, although complications have been reported [25]. Application of deep electrocautery too close to the bronchial wall may result in perforation and pneumothorax. Cartilaginous rings may be destroyed, leading to a loss of structural support, tracheo- or bronchomalacia, and/or secondary stenosis [26].

Conclusion

Overall, Fiber optic bronchoscopy is generally considered as a safe and effective procedure for diagnosis and treatment of airway and pulmonary pathology. Multiple complications have been associated with bronchoscopy and can widely vary from cough and mild hypoxia to severe life threatening complications such as bleeding, pneumothorax and rarely death. More attention should be paid to patients with high levels of comorbid disease and those with limited pulmonary reserve such as COPD patients. The likelihood of a complication is minimized by appropriate patient selection, careful evaluation of the risk-benefit ratio in high risk patients, and adherence to patient safety protocols. Thus, bronchoscopy requires skilled personnel and considerable training and experiences to insure patients' safety and best outcomes.

References

1. Stahl DL, Richard KM, Papadimos TJ. Complications of bronchoscopy: A concise synopsis. Int J Crit Illn Inj Sci. 2015;5(3):189-95.
2. Bellinger CR, Khan I, Chatterjee AB, Haponik EF. Bronchoscopy safety in patients with Chronic obstructive lung disaese. Journal of Bronchology & Interventional Pulmonology. 2016.
3. Chadha M, Kulshrestha M, Biyani A. Anaesthesia for Bronchoscopy. Indian J Aneasth. 2015;59(9):565-73.
4. Schnabel RM, van der Velden K, Osinski A, Rohde G, Roekaerts PM, Bergmans DC. Clinical Course and Complications Following Diagnostic Bronchoalveolar Lavage in Critically Ill Mechanically Ventilated Patients. BMC Pulm Med. 2015;15:107.
5. Lucangelo U, Vassallo FG, Marras E, Ferluga M, Beziza E, Comuzzi L, et al. High-flow Nasal Interface Improves Oxygenation in Patients Undergoing Bronchoscopy. Crit Care Res Pract. 2012;2012:506382.
6. Gavel G, Walker RWM. Laryngospasm in anaesthesia. Contin Educ Anaesth Crit Care Pain. 2014;14(2):47-51.
7. Goudra BG, Singh PM, Manjunath AK, Reihmer JW, Haas AR, Lanfranco AR, et al. Effectiveness of high dose remifentanil in preventing coughing and laryngospasm in non-paralyzed patients for advanced bronchoscopic procedures. Ann Thorac Med. 2014;9(1):23-8.
8. Regional and Topical Anesthesia for Endotracheal Intubation. The New York School of Regional Anesthesia on line publication.
9. Rankin JA, Snyder PE, Schachter EN, Matthay RA. Bronchoalveolar lavage: its safety in subjects with mild asthma. Chest. 1984;85(6):723-8.
10. Jarjour NN, Peters SP, Djukanović R, Calhoun WJ. Investigative use of bronchoscopy in asthma. Am J Respir Crit Care Med. 1998;157(3):692-7.
11. Cox G, Miller JD, McWilliams A, Fitzgerald JM, Lam S. Bronchial thermoplasty for asthma. Am J Respir Crit Care Med. 2006;173(9):965-9.
12. Stolz D, Pollak V, Chhajed PN, Gysin C, Pflimlin E, Tamm M. A randomized, placebo-controlled trial of bronchodilators for bronchoscopy in patients with COPD. Chest. 2007;131(3):765-72.
13. Pue CA, Pacht ER. Complications of Fiberoptic Bronchoscopy at a University Hospital. Chest. 1995;107(2):430-2.
14. Eapen GA, Shah AM, Lei X, Jimenez CA, Morice RC, Yarmus L, et al. Complications, consequences, and practice patterns of endobronchial ultrasound-guided transbronchial needle aspiration: Results of the AQuIRE registry. Chest. 2013;143:1044-53.
15. Ernst A, Eberhardt R, Wahidi M, Becker HD, Herth FJ. Effect of routine clopidogrel use on bleeding complications after transbronchial biopsy in humans. Chest. 2006;129:734-7.
16. Kitamura S, Wagai F. Local administration of cold saline for the treatment of bleeding induced by transbronchial biopsy. J Jpn Soc Bronchol. 1984;6:309.
17. Kitamura S. Local administration of thrombin solution for the treatment of intrabronchial bleeding. Internal Med (Tokyo). 1984;53:747.
18. Cordasco EM, Mehta AC, Ahmad M. Bronchoscopically induced bleeding. A summary of nine years' Cleveland clinic experience and review of the literature. Chest. 1991;100:1141-7.
19. Ost DE, Ernst A, Lei X, Kovitz KL, Benzaquen S, Diaz-Mendoza J, et al. Diagnostic Yield and Complications of Bronchoscopy for Peripheral Lung Lesions. Results of the AQuIRE Registry. Am J Respir Crit Care Med. 2016;193:68-77.
20. Huang Y, Huang H, Li Q, Browning RF, Parrish S, Turner JF, et al. Transbronchial lung biopsy and pneumothorax. J Thorac Dis. 2014;6:S443-7.
21. Reddy C, Majid A, Michaud G, Feller-Kopman D, Eberhardt R, Herth F, et al. Gas embolism following bronchoscopic argon plasma coagulation: a case series. Chest. 2008;134:1066-9.
22. Shaw Y, Yoneda KY, Chan AL. Cerebral gas embolism from bronchoscopic argon plasma coagulation: a case report. Respiration. 2012;83:267-70.
23. Matveychuk A, Guber A, Talker O, Shitrit D. Incidence of bacteremia following bronchoscopy with argon plasma coagulation: a prospective study. Lung. 2014;192:615-8.
24. Colt HG, Crawford SW. *In vitro* study of the safety limits of bronchoscopic argon plasma coagulation in the presence of airway stents. Respirology. 2006;11:643-7.
25. Wahidi MM, Unroe MA, Adlakha N, Beyea M, Shofer SL. The use of electrocautery as the primary ablation modality for malignant and benign airway obstruction. J Thorac Oncol. 2011;6:1516-20.
26. Verkindre C, Brichet A, Maurage CA, Ramon P, Homasson JP, Marquette CH. Morphological changes induced by extensive endobronchial electrocautery. Eur Respir J. 1999;14:796.