Original Article

Hypoxemia During Bronchoscopy and The Risk Factors Related

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Abstract

Background: Hypoxemia, a common complication of bronchoscopy, often occurs even with oxygen supplementation, particularly during procedures performed under sedation, with reported incidences ranging from 2.5% to 69%. Hypoxemia during bronchoscopy which is defined as desaturation under 90% or more than 5% decreasing of basal SpO_2, becomes a concern due to possible fatal complications. This study aims to determine the incidence of hypoxemia during bronchoscopy and identify its predisposing risk factors.

Methods: An analytic observational study with a cross-sectional design was held in our center from October 2022 until June 2023. As many as 100 consecutive patients who underwent bronchoscopy and met inclusion criteria were evaluated prospectively. The patient's oxygen saturation was monitored by finger pulse oximetry during the procedure. Demographic characteristics, comorbidities, lung function, PaO_2 value, ASA score, types of intervention, sedative agents, duration of sedation and procedure were recorded. The risk factors for hypoxemia during bronchoscopy were evaluated.

Results: The incidence of hypoxemia during bronchoscopy in our center was 15%. Bivariate analysis showed pleural effusion as a comorbidity (9 patients; 60%), restrictive-obstructive lung function test (10 patients; 66.7%) and PaO_2 value (76.87±8.219) were statistically significant (P<0.05) related to the existence of hypoxemia during bronchoscopy. Three other factors such as age, ASA score and duration of procedure with P<0.25 were included in multivariate analysis and found that the most influencing factor was the restrictive-obstructive lung function test (P=0.001; OR=13.845).

Conclusion: Comorbidity (pleural effusion), lung function (restrictive-obstructive) and PaO_2 value were some factors significantly related to hypoxemia during bronchoscopy with lung function being the most influencing factor.

Keywords: bronchoscopy, desaturation, hypoxemia

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INTRODUCTION

Bronchoscopy is an invasive procedure used to assess the tracheobronchial tree, playing a crucial role in diagnosing and managing lung diseases.[1] The indication for bronchoscopy at the beginning of its development was as a therapeutic procedure such as removal of foreign bodies and dilation of strictures caused by tuberculosis and diphtheria infections. The increase in lung cancer cases throughout the world has resulted in many cases of airway obstruction caused by malignant tumors or benign stenosis, thereby replacing airway foreign body removal as the main indication for therapeutic bronchoscopy.[2,3]

Shigeto Ikeda in 1963 first introduced flexible fiber optic bronchoscopy as a diagnostic procedure. Bronchoscopy is performed to collect biopsy samples, but it is also important for assessing mediastinal lymph nodes as a component in determining the staging of lung cancer patients. The sensitivity of bronchoscopy in diagnosing lung cancer with a central lesion location is 88% while for peripheral lesions 34–63%. Bronchoscopy is a relatively safe procedure with complications occurring in <1% of cases and a mortality rate of 0.04%. Some complications of bronchoscopy include respiratory distress, bleeding, pneumothorax, infection and cardiac arrhythmia.[4–8]

Hypoxemia as a complication of bronchoscopy often occurs even though the patient has been given oxygen supplementation, especially if the procedure uses sedation.[6] The average PaO_2 decreases about 20 mmHg during bronchoscopy with a decrease range of 4–38 mmHg.[9,10]

Hypoxemia during bronchoscopy procedures is defined as a decrease of more than 5% in peripheral oxygen saturation (SpO_2) from basal or SpO_2 <90% for more than one minute during a bronchoscopy procedure.[6]

Hypoxemia is an important complication of bronchoscopy with an incidence rate of 2.5-69%.[11] Decreased SpO_2 is generally temporary and improves quickly but the operator should consider stopping the procedure if hypoxemia persists for more than one minute.[6] The British Thoracic Society (BTS) recommends routine oxygen saturation during bronchoscopy.[7,11] Hypoxemia during bronchoscopy is generally caused by upper airway obstruction, BAL procedure, suctioning, hypoventilation due to excessive sedation, inadequate oxygen supplementation, bleeding, bronchospasm, laryngospasm and pneumothorax secondary to TBLB or other interventional procedures.[12,13]

The mechanism of hypoxemia during bronchoscopy is ventilation-perfusion (V/Q) mismatch and secondary hypoventilation due to sedation.[14] A lower V/Q ratio causes a decrease in alveolar oxygen concentration and followed by a decrease in arterial oxygen concentration resulting in hypoxemia.[15]

A significant decrease in SpO_2 is generally seen when the patient begins to be sedated and gets worse when the bronchoscope passes through the vocal cords.[16] Hypoxemia during bronchoscopy is something that must be considered because it can cause fatal complications such as cardiac arrhythmias, coronary artery disorders, neurological disorders and acute respiratory distress.[6,7]

Risk factors related to hypoxemia events during bronchoscopy procedures from some studies include age, low Forced Expiratory Volume in 1 second (FEV_1), lung diseases such as Chronic Obstructive Pulmonary Disease (COPD), duration of sedation, use of respiratory depressed medication, additional procedures and position during bronchoscopy.[6,7] The aims of this study are to determine the incidence of hypoxemia during bronchoscopy in our center and the risk factors related.

METHODS

This cross-sectional analytical study was conducted at Arifin Achmad Regional General Hospital, Riau Province, from October 2022 to June 2023. We looked at the incidence of hypoxemia, which was characterized by a decrease in SpO_2 to less than 90% for more than 1 minute during bronchoscopy procedures, in patients who had both diagnostic and therapeutic indications and analyzed the risk factors that influenced it. Oxygen Saturation was observed during the procedure by using pulse oximetry. A minimum sample size of 83 people was obtained by using the Lemeshow formula (1997). Sampling was carried out using a consecutive sampling technique.

Patients who met the inclusion criteria, including being >18 years old, met the requirements for bronchoscopy, able to undergo a spirometry examination before bronchoscopy, not experienced hypoxemia before the bronchoscopy procedure, namely a PaO_2 value <60mmHg from blood gas analysis and a SpO_2 value <90% by pulse oximetry.

Patients with pre-procedure hypercapnia ($PaCO_2$ >45 mmHg) were excluded and the patient is willing to become a respondent by signing a letter of agreement. Patients who experienced other complications before hypoxemia occurred so that the procedure was stopped, such as cardiac arrhythmias, were excluded from this study.

There are 14 independent variables (risk factors) in this study, namely age, gender, BMI, pulmonary comorbidity, smoking habits, ASA score, lung function obtained from spirometry examination 24 hours before the procedure, PaO_2 value from blood gas analysis, underlying disease, type of oxygen supplementation device used during the procedure, type of additional diagnostic procedure, type of sedation medication, duration of procedure and sedation. Meanwhile, the dependent variable is hypoxemia which occurs during the bronchoscopy procedure. Data was taken and then processed and analyzed using SPSS v.25 software.

Bivariate analysis was carried out using the chi-square and unpaired T-test. If it does not meet the requirements then will use Fisher or Kolmogorov-Smirnov and Mann-Whitney test as an alternative. A value of $P<0.05$ was considered significant based on statistical analysis. Furthermore, a multivariate analysis was carried out on all variables with a value of $P<0.25$ using logistic regression to obtain a formulation for predictors of hypoxemia during bronchoscopy. This study has been declared to have passed ethical review by the Ethical Review Board for Medicine and Health Research of the Faculty of Medicine, Riau University.

RESULTS

There were 139 patients who underwent bronchoscopy procedures at our center during the study period, 39 of whom did not meet the inclusion criteria because they were <18 years old, unable to undergo spirometry procedures and the patients were diagnosed with respiratory failure and placed on mechanical ventilation in the intensive care unit. No patients were excluded from this study (Figure 1). We observed the incidence of hypoxemia during bronchoscopy procedures and the factors that related.

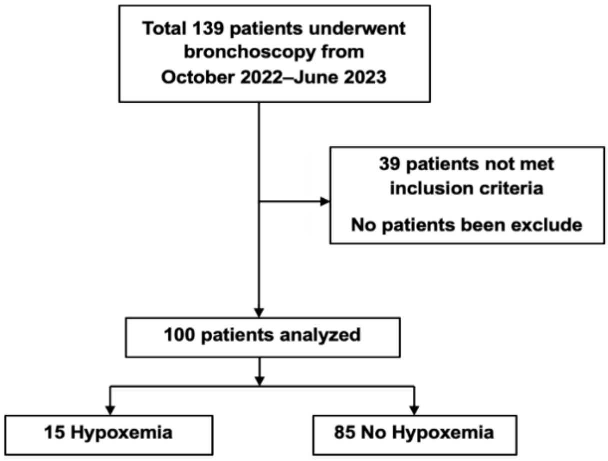

Figure 1. Flow chart of the inclusion and exclusion procedures for the study

Among 100 patients, 15% experienced hypoxemia during bronchoscopy. Hypoxemia generally occurred when the bronchoscope was inserted to the airway, 2 incidents occurred when sedation was started, 4 incidents occurred when additional procedures were performed and 1 incident occurred after the procedure. The average duration of hypoxemia was 2 minutes, with a maximum duration of 2 minutes and 42 seconds. The action taken for patients who experienced hypoxemia during the procedure was to pull the bronchoscope out and perform maximum oxygenation with a bag and mask.

Table 1. Baseline characteristic of subjects according to occurrence of hypoxemia during bronchoscopy (n=100)

Subject Characteristic	n (%)	Mean±SD or Median (min-max)	Bronchoscopy Procedure		*P*
			Hypoxemia	No hypoxemia	
Age, years	---	55 (18–73)	47 (20–63)	55 (18–73)	0.244[a]
Sex					
Male	71 (71%)	---	9 (60%)	62 (72,9%)	0.359[b]
Female	29 (29%)	---	6 (40%)	23 (27.1%)	
BMI, kg/m^2	---	19.49 (13.3–34.52)	19.11 (17.52–27.50)	19.50 (13.30–34.52)	0.969[a]
Smoking Habits, cigarettes/years	---	452 (0–1920)	272 (0–1472)	456 (0–1920)	0.595[a]
Pulmonary Comorbidity					
Atelectasis	2 (2%)	---	0 (0%)	2 (2.35%)	
Pleural effusion	28 (28%)	---	9 (60%)	19 (22,35%)	
Pulmonary infection	10 (10%)	---	2 (13.3%)	8 (9.41%)	
COPD	5 (5%)	---	0 (0%)	5 (5.88%)	
SVCS	1 (1%)	---	0 (0%)	1 (1.17%)	
Effusion + Atelectasis	1 (1%)	---	0 (0%)	1 (1.17%)	
Effusion + Infection	2 (2%)	---	0 (0%)	2 (2.35%)	**0.04[c]**
Effusion + COPD	3 (3%)	---	0 (0%)	3 (3.52%)	
Effusion + SVCS	1 (1%)	---	0 (0%)	1 (1.17%)	
Effusion + COPD + Infection	1 (1%)	---	0 (0%)	1 (1.17%)	
Effusion + COPD + SVCS	1 (1%)	---	0 (0%)	1 (1.17%)	
SVCS + Infection	1 (1%)	---	0 (0%)	1 (1.17%)	
None	44 (44%)	---	4 (34.7%)	40 (47.05%)	

Subject Characteristic	n (%)	Mean±SD or Median (min-max)	Bronchoscopy Procedure		*P*
			Hypoxemia	No hypoxemia	
Underlying Disease					
Lung tumor	94 (94%)	---	14 (93.3%)	80 (94.1%)	1.000[b]
Non-tumor	6 (6%)	---	1 (6.7%)	5 (5.9%)	1.000[b]
Lung Function					
Normal	7 (7%)	---	0 (0)	7 (8.2%)	**0.004[c]**
Restrictive	60 (60%)	---	4 (26.7)	56 (65.9%)	
Obstructive	8 (8%)	---	1 (6.6)	7 (8.2%)	
Restrictive-Obstructive	25 (25%)	---	10 (66.7)	15 (17.7%)	
PaO_2 Value, mmHg	---	81.87±8.774	76.87±8.219	82.75±8.615	**0.02[d]**
ASA Score					
ASA II	85 (85%)	---	11 (73.3%)	74 (87.1%)	0.233[b]
ASA III	15 (15%)	---	4 (26.7%)	11 (12.9%)	
O_2 Suplementation Device					
Nasal Cannula	45 (45%)	---	7 (46.7%)	38 (44.7%)	0.578[e]
LMA	48 (48%)	---	6 (40%)	42 (49.4%)	0.578[e]
ETT	7 (7%)	---	2 (13.3%)	5 (5.9%)	0.578[e]
Sedation Agent					
Propofol + Fentanyl	50 (50%)	---	6 (40%)	44 (51.8%)	0.995[c]
Propofol + Fentanyl + Sevoflurane	33 (33%)	---	6 (40%)	27 (31.8%)	
Propofol + Fentanyl + Midazolam	6 (6%)	---	1 (6.7%)	5 (5.9%)	
Pprpofol + Fentanyl + Ketamine	2 (2%)	---	0 (0%)	2 (2.4)	
Fentanyl + Sevoflurane + Midazolam	1 (1%)	---	1 (6.7%)	0 (0%)	
Prorpofol + Fentanyl + Midazolam + Ketamine	1 (1%)	---	0 (0%)	1 (1.2%)	
Propofol + Fentanyl + Sevoflurane + Ketamine	2 (2%)	---	0 (0%)	2 (2.4%)	
Propofol + Fentanyl + Sevoflurane + Midazolam	5 (5%)	---	1 (6.7%)	4 (4.7%)	
Additional Procedure					
Rinsing	11 (11%)	---	4 (26.7%)	7 (8.2%)	0.779[c]
Rinsing + Brushing	42 (42%)	---	4 (26.7%)	38 (44.7%)	
Rinsing + Forcep	17 (17%)	---	4 (26.7%)	13 (15.3%)	
Rinsing + Brushing + Forcep	20 (20%)	---	1 (6.7%)	19 (22.4%)	
Rinsing + Brushing + Needle	3 (3%)	---	0 (0%)	3 (3.5%)	
Rinsing+Brushing + Needle + Forcep	6 (6%)	---	1 (6.7%)	5 (5.9%)	
None	1 (1%)	---	1 (6.7%)	0 (0%)	
Duration of Procedure, minutes	---	30 (10–70)	25 (15–45)	30 (10–70)	0.189[a]
Duration of Sedation, minutes	---	45 (25–80)	45 (25–60)	45 (25–80)	0.812[a]

Note: [a]Mann-Whitney; [b]Fisher exact test; [c]Kolmogorov-Smirnov; [d]Unpaired T-test; [e]Chi-Square

Bivariate analysis revealed statistically significant relationships between lung function (P=0.004), pulmonary comorbidities (P=0.04), and basal PaO_2 values (P=0.02) and the incidence of hypoxemia during bronchoscopy (Table 1). Risk factor variables that have a value of P<0.25 in the bivariate analysis are eligible for inclusion in the multivariate logistic regression analysis which was age (P=0.244), pulmonary function (P=0.004), PaO_2 value (P=0.02), pulmonary comorbidities (P=0.04), ASA score (P=0.233) and procedure duration (P=0.189).

The results obtained from the multivariate analysis discover that age (P=0.019; OR=1.069) and restrictive-obstructive lung function (P=0.001; OR=13.845) were the most influencing factors on the incidence of hypoxemia in patients undergoing bronchoscopy (Table 2). The risk of hypoxemia during bronchoscopy will increase 1.069 times every year additional of ages and 13.845 times in patients with mixed lung function disorder (restrictive-obstructive).

Table 2. Multivariate analysis for predictors of hypoxemia during bronchoscopy

Risk Factors	*P*	OR	95% CI
Age every year older	0.019	1.069	1.011-1.131
Mixed Restrictive-obstructive disorder	<0.01	13.845	2.918-65.681

DISCUSSION

Hypoxemia can occur due to four mechanisms: ventilation-perfusion (V/Q) mismatch, right-to-left shunting, impaired diffusion, and hypoventilation. Hypoxemia during bronchoscopy procedures can occur through the mechanism of ventilation-perfusion (V/Q) mismatch as a consequence of bronchoconstriction reflex due to mechanical stimulation of subepithelial receptors by the bronchoscope, partial airway obstruction by the bronchoscope, suctioning as well as local anesthetic solutions and rinsing fluids in the alveoli.[15,17]

Apart from that, hypoxemia during bronchoscopy procedures can also occur through the mechanism of secondary hypoventilation due to sedation using opioids, benzodiazepines and hypnotics. Hypoxemia can occur due to four mechanisms: ventilation-perfusion (V/Q) mismatch, right-to-left shunting, impaired diffusion, and hypoventilation.[6,7]

This study used a cross-sectional design to observe 14 variables that hypothetically increase the risk of hypoxemia during bronchoscopy procedures include age, gender, BMI, pulmonary comorbidities, smoking habits, underlying disease, PaO_2 value, lung function, ASA score, type of oxygen supplementation device, type of sedation medication, type of additional procedure, duration of procedure and duration of sedation. The incidence of hypoxemia as an important complication of bronchoscopy is around 2.5–69%.[11]

This study found the incidence of hypoxemia during bronchoscopy at our center is 15% which is not much different from a study from Putra et al at Persahabatan Hospital (20,5%)[7]. The study from Kumar et al in 100 patients undergoing Fibreoptic Bronchoscopy (FOB) procedure found out all patients developed a fall in PaO2 following FOB but hypoxemia was noted only in 18 cases (18%).[18]

Most of the hypoxemia that occurs during bronchoscopy procedures (93.3%) can be overcome by providing adequate oxygen supplementation, which means they have a good response to the administration of additional oxygen. This is in accordance with the characteristics of hypoxemia which occurs through the mechanism of ventilation perfusion mismatch and secondary hypoventilation.[17] There were no serious complications leading to death in this study so it can be concluded that the bronchoscopy procedure was safe to carry out and had a small risk of death as stated in several literatures which is less than 0.04%.[7]

Analysis of the correlation between demographic characteristics such as age, gender, BMI, pulmonary comorbidities and smoking habits with incidence of hypoxemia showed that only pulmonary comorbidity which is pleural effusion, had a statistically significant result (p=0.04). Pleural effusion is a condition that is often found in patients with lung malignancies. In this study we found that 9 of 28 (32.14%) patients with pleural effusion experienced desaturation during bronchoscopy, while Shinagawa et al found it in 79 of 328 (24%) patients.[13] Pleural effusion is associated with expansion of the chest wall volume which reduces the efficiency of the inspiratory muscles resulting hypoxemia through the hypoventilation mechanism. The nature of pulmonary gas exchange can also be influenced by pleural effusion. Theoretically, it is estimated that a decrease in functional residual capacity (FRC) caused by pleural effusion can reduce end-expiratory lung volume to near or even below closing volume, a condition associated with hypoxemia through the V/Q mismatch mechanism.[19]

Bivariate analysis of age did not show a significant correlation (*P*=0.244) but gave significant results in multivariate analysis (*P*=0.019; OR=1.069). A study by Choi et al on 2520 patients undergoing bronchoscopy also found that age had a significant correlation with the incidence of hypoxemia during bronchoscopy (OR=1.32).[6]

Shinagawa et al and Irmak et al in their study also found a significant correlation between age with the occurrence of hypoxemia during bronchoscopy.[13,20] V/Q mismatch causes a decrease in PaO_2 with widening A-a gradients, the basis for the pathophysiology of hypoxemia in the elderly. Changes in respiratory function in the elderly such as decreasing chest wall compliance and elastic recoil, increasing lung compliance, respiratory muscles weakening and alveoli enlarging are the basis for V/Q mismatch.[9,17]

Lung function examination before the bronchoscopy procedure is not a routine examination. Abnormal lung function is also not a contraindication to a bronchoscopy procedure. This study assessed the correlation between lung function before the procedure and the incidence of hypoxemia during bronchoscopy. Of the 100 patients who underwent the bronchoscopy procedure, lung function examination results showed that 60% had restrictive disorders, 8% obstructive disorders, 25% mixed disorders and 7% normal. Of the 15 patients who experienced hypoxemia during the bronchoscopy procedure, 10 patients (66.7%) had mixed lung function disorders. Bivariate analysis showed statistically significant results with a value of P=0.004 and multivariate analysis showed the value of P for mixed lung function disorders of 0.001 (OR=13.845).

The study conducted by Choi et al, Vasko et al, Shinagawa et al and Jones et al found that the FEV_1 value was one of the factors that could predict the occurrence of hypoxemia during bronchoscopy.[6,11,13,21] This shows that airway obstruction has a greater influence on the incidence of hypoxemia compared to pulmonary restriction. In line with the findings in this study, of the 60 patients with restriction disorders, only 4 patients (6.6%) experienced hypoxemia and the incidence increased when patients with pulmonary restriction also had airway obstruction from their lung function test results. A decrease in FEV_1 values indicates airflow obstruction so bronchoscopy in patients with low FEV_1 values can increase the risk of V/Q mismatch causing hypoxemia.[12,22,23]

Bivariate analysis of the correlation between PaO_2 values and the incidence of hypoxemia during bronchoscopy procedures showed that there was a statistically significant difference in mean PaO_2 values between the group of patients who experienced hypoxemia (76.87±8.219 mmHg) compared to the group who did not (82.75±8.615 mmHg) with a value of P=0.02. A study by Fang et al found that patients requiring oxygen supplementation before the procedure could be a predictive factor for desaturation during the procedure, but the basal SpO_2 value could not be used as a prediction for desaturation during the procedure.[24]

This study showed that BMI did not have a significant correlation to the incidence of hypoxemia during bronchoscopy procedures (P=0.969). These findings are in line with the results obtained by Choi et al on 2,520 patients who underwent bronchoscopy procedures under sedation.[6] A study by Irmak et al also showed that there was no correlation between BMI and the incidence of hypoxemia during bronchoscopy.[20]

Hypoxemia during bronchoscopy tends to occur in obese patients. According to a study by Salahuddin et al in the obese population undergoing bronchoscopy procedures, severe hypoxemia as a major complication was found at 0.6% and hypoxemia as a minor complication at 13.3%.[25] Of the 100 patients in our study there were only 7 patients with obesity (BMI ≥25kg/m^2) and 2 of them (28.5%) experienced hypoxemia during bronchoscopy.

The results of this study did not show a significant correlation between the patient's smoking habits and the incidence of hypoxemia during bronchoscopy. There are differences in determining the study’s variables, in the two previous studies by Putra et al and Vasko et al smoking history was grouped into smoking and non-smoking while in this study smoking habits were assessed using data on the number of cigarettes consumed per year by the patient. A study by Choi et al and Irmak et al which used data on the number of cigarettes per year also provided insignificant results.[7,20]

Most of the bronchoscopy procedures performed in this study (94%) had diagnostic indications, therefore the most frequent underlying diseases found were lung tumours. Only 6% had therapeutic indications in patients with non-tumour diagnoses. Statistical analysis showed that there was no significant correlation between the diagnosis of lung disease which was an indication for a bronchoscopy procedure and the incidence of hypoxemia during the procedure. This could be caused by the difference in sample size being too large between the two groups.

A total of 85 patients (85%) had an ASA score of II and 15 patients (15%) had an ASA score of III assessed by an anesthesiologist before the procedure. Hypoxemia during bronchoscopy occurred more frequently in patients with ASA II, 11 out of 15 patients (73.3%), but if we look at the tendency for hypoxemia to occur in each ASA score group, patients with an ASA score of III were more likely to experience hypoxemia, 26.7% compared to patients with an ASA score II 12.9%. This finding was not statistically significant (*P*=0.233). A study by Ost et al found that an ASA score of more than III and emergency procedures were risk factors for complications of therapeutic bronchoscopy procedures in patients with airway obstruction by malignancy mass.[26] Meanwhile, in a study by Özbudak et al, no correlation was found between ASA scores and complications during the EBUS-TBNA procedure.[27]

Of the 15 patients who experienced hypoxemia during bronchoscopy procedures, 7 patients (46.7%) were given O_2 supplementation via nasal cannula, 6 patients (40%) via LMA and 2 patients (13.3%) via ETT. We found that oxygen supplementation devices were not significantly related to the incidence of hypoxemia during bronchoscopy at our center (*P*=0.578). A study by Putra et al also showed that there was only a slight difference in the proportion of hypoxemia in patients using nasal cannulas (18%) and LMA (19.2%), while different study results were obtained by El-Hameed et al and Rafaat et al which showed that the group of patients using nasal cannulas had a higher incidence of hypoxemia than the LMA group with a significant difference.[7,28,29] The use of LMA and ETT has the advantage of maintaining upper airway patency and a wider lumen, thereby reducing the effect of partial obstruction of the upper airway when the bronchoscope is inserted.[7]

The combination of propofol and fentanyl was the most frequently used combination of sedation drugs in this study, 50 of 100 patients (50%). Of the 15 patients who experienced hypoxemia, most were found in the group of patients who used a combination of propofol and fentanyl and propofol, fentanyl and sevoflurane, 6 patients each (40%). This finding was not statistically significant (*P*=0.995). Stolz et al conducted a study to compare the use of propofol alone and in combination with other sedation drugs (benzodiazepines and opioids) in patients undergoing bronchoscopy. No significant difference was found between the two groups in the incidence of desaturation during bronchoscopy procedures.[30]

The bronchoscopy procedure at our center is generally carried out for diagnostic indications in lung cancer patients. Additional procedures are carried out to obtain samples to confirm the type of cancer cells. These additional procedures include rinsing, brushing, forceps and needle biopsy. There were six groups of additional procedures in this study with the most frequently performed were rinses and brushes (42 patients). Of the 15 patients who experienced hypoxemia, 4 patients each (26.7%) were patients from the rinse, rinse and brush, rinse and forceps biopsy groups. Fang et al in their study found that although all interventional procedures and their complications can cause desaturation, there is a specific type of procedure that can predict the occurrence of desaturation, namely Bronchoalveolar Lavage (BAL).[24]

This finding is also in line with several other studies that state that bronchoscopy followed by BAL increases the risk of developing hypoxemia, especially if the amount of rinsing fluid used is quite large.[2,14,31] In our study there were no patients who undergo bronchoscopy with BAL procedures, the results obtained indicate that there is no difference in the risk of hypoxemia occurring during the bronchoscopy procedure due to the additional rinsing procedure, brushing, forceps and needle biopsy (*P*=0.779).

The duration of the procedure in this study ranged from 10 to 70 minutes with a median of 30 minutes and in the group experiencing hypoxemia the median value was 25 minutes (15–45) while the duration of sedation ranged from 25 to 80 minutes with a median of 45 minutes and in the group experiencing hypoxemia it was obtained median value 45 minutes (25–60). Analysis of the correlation between the duration of the procedure and sedation with the incidence of hypoxemia during the procedure did not provide statistically significant results with values of P=0.189 and 0.812, respectively. In a study by Yang et al in 244 patients duration of a bronchoscopy procedure that exceeds 30 minutes was closely related to the occurrence of hypoxemia.[32]

In this study, duration data was presented on a numerical scale and had an abnormal distribution, whereas a previous study by Choi et al grouped duration data into two groups, which were more than 40 minutes and less than 40 minutes so that differences in results might occur.[6] In this study, almost all patients were given sedation using propofol. Propofol is a hypnotic-sedative agent with a fast onset of action and recovery time. A study by Stolz et al showed that if oxygen supplementation was given during bronchoscopy procedures, propofol did not cause a large decrease in oxygen saturation.[30]

LIMITATIONS

This study used a cross-sectional method with several difficult-to-avoid limitations which could influence the research results. This research design only determines the correlation between factors that influence the incidence of hypoxemia at one time and cannot describe a causal correlation, so to get valid results a large sample size is needed. Sample homogeneity, particularly the underrepresentation of patients with therapeutic bronchoscopy indications, limits the generalizability of findings. The target population in this study was patients undergoing bronchoscopy for either diagnostic or therapeutic indications. However, along the way, many patients with therapeutic indications did not meet the inclusion criteria so the sample size of patients with therapeutic indications did not represent the group.

CONCLUSION

Restrictive-obstructive lung function disorders and age were the most significant factors associated with hypoxemia during bronchoscopy in our center. Routine spirometry examinations before bronchoscopy are recommended to identify high-risk patients and allow for preventive measures with the aim that operators and anaesthesiologists can carry out bronchoscopy procedures more carefully and take preventive action before the procedure is carried out. Bronchoscopy in older patients requires additional precautions to minimize the risk of hypoxemia.

CONFLICT OF INTEREST

No potential conflict of interest relevant to this article was reported.

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