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RESEARCH ARTICLE
KLİNİK ÇALIŞMA

# Factors related to oxygen desaturation during flexible bronchoscopy and endobronchial ultrasound

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**ABSTRACT**

**Factors related to oxygen desaturation during flexible bronchoscopy and endobronchial ultrasound**

**Introduction:** *Oxygen desaturation is a significant event during bronchoscopy. In this study, it was aimed to identify factors related to oxygen desaturation during flexible bronchoscopy (FB) and Endobronchial ultrasound (EBUS).*

**Materials and Methods:** *From 16 April 2019 to 14 February 2020, 196 consecutive patients (146 FB and 50 EBUS) undergoing bronchoscopy were evaluated retrospectively. The patients' oxygen saturations were monitored on admission and during the procedure by finger pulse oximetry. Desaturation was defined as saturation below 90%. Demographic characteristics, comorbidities, types of interventions, vitals before and during the procedure, amount of saturation decline, and sedative agents used were recorded. The data obtained were compared between the desaturated and non-desaturated groups in both FB and EBUS. We evaluated the risk factors for desaturation during bronchoscopic procedures.*

**Results:** *The mean age of those who underwent FB was higher (62 [52-68] years vs. 55 [44-65] years, p= 0.05), and males were more frequent (54%, vs 19.2%, p< 0.001) in the desaturated group. In FB, short lavage was more frequent in the non-desaturated group (28.8% vs. 9.5%, p< 0.001). In EBUS, hypertension, diabetes mellitus and thyroid diseases were higher, and duration of procedure was longer (p= 0.02, p= 0.04, p= 0.01 and p <0.001, respectively) in the desaturated group. In both FB and EBUS, baseline $SpO_2$ was lower (96% vs. 98% in FB, 97% vs. 98% in EBUS, p< 0.001 and p= 0.01, respectively), and $SpO_2$ decline during procedures was higher (11% vs. 1% in FB, 18% vs. 3% in EBUS, p< 0.001, each) in the desaturated group.*

**Conclusion:** *This study suggested that baseline $SpO_2$ and $SpO_2$ decline during procedures as well as sex, hypertension, and concomitant endocrine - metabolic diseases, duration of procedure were factors associated with desaturation in patients who had undergone FB and EBUS.*

**Key words:** *Bronchoscopy; oxygen desaturation; endobronchial ultrasound, flexible bronchoscopy*

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**ÖZ**

**Flexible bronkoskopi ve endobronşiyal ultrasonda oksijen desatürasyonu ile ilişkili faktörler**

**Giriş:** *Oksijen desatürasyonu, bronkoskopi sırasında gelişebilen önemli bir olaydır. Flexible bronkoskopi (FB) ve Endobronşiyal Ultrason (EBUS) sırasında oksijen desatürasyonu ile ilişkili faktörleri belirlemeyi amaçladık.*

**Materyal ve Metod:** *16 Nisan 2019'dan 14 Şubat 2020'ye kadar, bronkoskopi yapılan 196 ardışık hasta (146 FB ve 50 EBUS) retrospektif olarak değerlendirildi. Hastaların oksijen satürasyonları, başvuru sırasında ve işlem sırasında parmak nabız oksimetresi ile izlendi. Desatürasyon,%90'ın altındaki satürasyon olarak tanımlandı. Demografik özellikler, komorbiditeler, işlem türleri, işlem öncesi ve sırasındaki vital değerler, satürasyon düşüş miktarı ve kullanılan sedatif ajanlar kaydedildi. Elde edilen veriler hem FB hem de EBUS'da desatüre olan ve olmayanlar arasında karşılaştırıldı. Bronkoskopik işlemler sırasında desatürasyon için risk faktörlerini inceledik.*

**Bulgular:** *Desatüre grupta FB uygulananların ortalama yaşı desatüre olmayan gruba göre daha yüksekti (62 [52-68] yaş vs. 55 [44-65] yaş, p= 0,05) ve erkekler daha fazla idi (%54, ile. % 19,2, p< 0,001). FB'de, kısa lavaj, desatüre olmayan grupta daha sıktı (%28,8'e ile %9,5, p< 0,001). EBUS'ta hipertansiyon, diabetes mellitus ve tiroid hastalıklarından oluşan komorbiditeler desatüre grupta daha fazla ve işlem süresi daha uzundu (sırasıyla p= 0,02, p= 0,04, p= 0,01 ve p< 0,001). Hem FB hem de EBUS'ta, desatüre grupta bazal $O_2$ satürasyonu daha düşük (FB'de %96 vs.%98, EBUS'ta %97 vs. %98, sırasıyla p< 0,001 ve p= 0,01) ve işlemde $SpO_2$ düşüşü daha fazlaydı (%11 ile %1 FB'de, %18 ile %3 EBUS'ta, p< 0,001, her biri).*

**Sonuç:** *Bu çalışma FB ve EBUS yapılan hastalarda işlem sırasında başlangıç $SpO_2$ ve $SpO_2$ düşüşünün yanı sıra cinsiyet, eşlik eden hipertansiyon ve endokrin - metabolik hastalıklar ve işlem süresinin desatürasyonla ilişkili faktörler olduğunu göstermektedir.*

**Anahtar kelimeler:** *Bronkoskopi; oksijen desatürasyon; endobronşiyal ultrason; flexible bronkoskopi*

## INTRODUCTION

Bronchoscopic procedures are considered safe and effective interventions that allow direct airway exposure, enable assessment and sampling of the tracheobronchial tree together with its surrounding structures. During bronchoscopic procedures, oxygen desaturation is a frequent occurrence with a rate of 94% (1). Although oxygen desaturation varies depending on the procedure, a decline in partial oxygen pressure ($PaO_2$) above 20 mmHg is reported (2). Desaturation might result from ventilation-perfusion mismatch (e.g., bleeding, bronchospasm), suctioning, partial airway occlusion by the endoscope, and hypoventilation associated with sedation (3). However, it is challenging to foresee oxygen desaturation during bronchoscopic interventions. Therefore, it is vital to determine the factors associated with desaturation for improving risk assessment and safety measures before the procedure. Previous studies identified poor overall condition, impaired lung function, advanced age, comorbidity, and specific procedure types as high-risk factors associated with oxygen desaturation (3-5).

A pulse oximeter is a practical and routine method that allows oxygen saturation monitoring in peripheral perfusion before and during the procedure (6). British Thoracic Society advises basal oxygen saturation ($SpO_2$) assessment, evaluation of comorbidities and of the procedure to be conducted before bronchoscopy for the complications associated with hypoxemia (7). Besides saturation follow-up with a pulse oximeter and oxygen support is recommended in case of desaturation (7).

Endobronchial ultrasound (EBUS) is a novel method for sampling structures in close proximity to the tracheobronchial tree as well as peripheral lesions. It is a compelling procedure to diagnose and stage lung cancer and has gained wide acceptance. Its different technical properties, more frequent use of sedation and longer procedural time may contribute to oxygen desaturation. There are a limited number of current studies where the factors directly associated with evaluating oxygen desaturation development in EBUS and Flexible bronchoscopy (FB) methods have been studied. We aimed to investigate factors related to $SpO_2$ decline and predictive factors of oxygen desaturation during FB and EBUS with the use of pulse oximetry.

## MATERIALS and METHODS

This retrospective study included consecutive patients who underwent bronchoscopy between 16 April 2019 and 14 February 2020 in a tertiary medical center. Patients were clustered into desaturated and non-desaturated groups in which either FB and EBUS were performed.

### Oxygen Desaturation

Oxygen desaturation was defined to be present when $SpO_2$ < 90%, regardless of whether the patient was receiving supplemental oxygen, with wave traces of pulsation on the monitor screen measured by finger probe before and during the procedures.

### Standard Procedures

Inpatients or outpatients were subjected to routine assessment before the procedure for suitability after deciding on bronchoscopy with various clinical indications. The operations were conducted in the bronchoscopy suite following 6-hours of fasting.

After assessments for hemorrhage risk, the patient's overall condition, vital findings, basal oxygen ($O_2$) level, amount of $O_2$ flow required, and circumstances leading to absolute contraindication (malign hypertension, recent acute ischemic attack, pneumothorax, etc.) were evaluated. After detailed information, patients' informed consent was obtained from all patients or their guardians before the procedures.

The nose, pharynx, and larynx were applied topically by sprayed with 2% lidocaine for local anesthesia. A fiberoptic bronchoscope was introduced orally or nasally, and vocal cords, trachea, and airways were anesthetized (2% lidocaine) under direct vision while the patient was supine. Pulse oximeter was applied to the index finger of the left hand, and $SpO_2$ was recorded. In non-cooperating patients, a parenteral midazolam sedative agent (conscious sedation) was used in FB when necessary. The patients who underwent EBUS were administered parenteral midazolam and propofol under the supervision of two anesthetists (unconscious sedation with protected spontaneous breath). A fiberoptic bronchoscope (Pentax, EB-1970K, HOYA Corporation, Tokyo, Japan) and/or EBUS (Olympus, EVIS EXERA III, CLV-190, UC180F, Olympus Medical Systems Corporation, Tokyo, Japan) were used in patients monitored for ECG, blood pressure, oxygen saturation (Philips, Efficia CM series, version A.01, Philips Medical Systems, Andover, U.S.A.), respiratory rate and visual inspection. Those with saturation below 90% before the procedure and those who developed desaturation during the process were provided oxygen with a flow from 2 to 16 L/min to keep $SpO_2$ above 90% (via nasal cannula, mask, or reservoir mask according to necessary).

Short lavage was done by injecting and aspirating 5-10 mL of sterile saline into the selected bronchial passage.

BAL was done by bronchoscope wedged into the segmental passage in the selected region and is performed with 100-200 mL sterile saline infusion and aspiration. Before each procedure, the lavage fluid was warmed to 37°C.

### Data

The data was collected from the files of the patients and the operating systems of the hospital. Patient demographics, comorbidities, smoking history, blood biochemistry, Complete Blood Count (CBC), International Normalized Ratio (INR) values, type of procedures, presence of expressed anxiety by patients (before the procedure, the verbal statement of the patient in questioning whether he or she felt anxiety about the procedure was recorded), route of application (nasal, oral), presence of an endobronchial lesion, presence of events including hemorrhage, arrhythmia, hypertension during the procedure, sedating agents used, duration of the procedure, vital values before and during the procedures including, systolic and diastolic blood pressure (SBP and DBP, mmHg), oxygen saturation ($SpO_2$, %), heart rate/minute were recorded.

### Statistical Analysis

The data were analyzed using IBM SPSS Statistics for Windows v.23.0 IBM Corp. Released in 2015 (8). The normality of variables was examined with the Shapiro-Wilk test, boxplots, and Q-Q plots. Descriptive statistics were shown as median, $25^{th}$, and $75^{th}$ percentiles as normality assumption was not satisfied. Furthermore, for continuous variables, independent two groups were compared with the Mann-Whitney U test. In contrast, categorical variables were compared with either Pearson's Chi Square test or Fisher's test both in FB and EBUS. The level of statistical significance was set at $p< 0.05$.

## RESULTS

One hundred and ninety-six study subjects consisted of 131 (66.8%) males and 65 (33.2%) females. Mean age was 60 years (18-88 years), and there were 68 subjects (34.7%) with a smoking history. One hundred forty-six (74.5%) subjects underwent FB and 50 (25.5%) underwent EBUS (Figure 1). The number of desaturated patients was 75 (38.2%) in total, 42 subjects (28.7%) in FB and 33 (66%) in EBUS.

Demographical and laboratory data of desaturated and non-desaturated groups in FB and EBUS procedures are given in Table 1. In those who underwent FB, the mean age (62 years vs. 55 years) was higher,

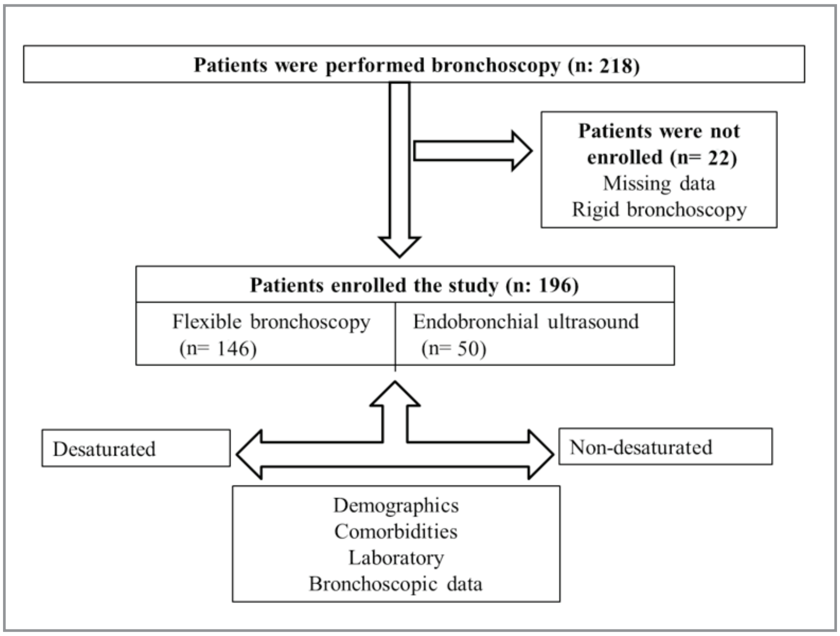


**Figure 1.** Flow chart of the study.

and the male sex (54% vs. 19.2%) more frequent in the desaturated group compared with the non-desaturated group (p= 0.05 and p< 0.001, respectively). In EBUS, comorbidities consisting of hypertension (42.4%, p= 0.02), diabetes mellitus (21.2%, p= 0.04), and thyroid diseases (30.3%, p= 0.01) were observed to be significantly higher. Other demographical and laboratory properties were similar in both groups for FB and EBUS.

Bronchoscopic data of FB and EBUS groups is shown in Table 2. In EBUS, anxiety expressed by the patient before the procedure was more frequent in the non-desaturated group (46.6% vs. 8.3%, p= 0.01), and the procedure time was longer in the desaturated group (p< 0.001). Both in FB and in EBUS; SBP, DBP, pre-procedure hypertension, route of administration and the sedative agents used in the procedure were similar (FB; p= 0.08, p= 0.35, p= 0.51, p= 0.29, p= 0.06, EBUS; p= 0.9, p= 0.59, p= 0.19, p= 0.65, p= 0.34, respectively). While all of the major bleeding was in the desaturated group in FB (4.7% vs. 0%, p= 0.02), no major bleeding was observed in EBUS. Both in FB and EBUS, basal $O_2$ levels (96% vs 98% in FB, 97% vs 98% in EBUS, p< 0.001 and p= 0.01, respectively), and the lowest $SpO_2$ in the procedure was significantly lower in the desaturated group, and $SpO_2$ variability was higher (85% vs 96% in FB, 79% vs 95% in EBUS, p< 0.001, each). In EBUS, the median oxygen support received by both the desaturated and non-desaturated group was higher than FB (15 L/min and 10 L/min in EBUS, 10 L/min, and 6 L/min in FB). None of the patients' required supplemental oxygen before the procedure. The plot graph of $SpO_2$ data of the study groups in FB and EBUS is shown in Figure 2.

No patient who underwent a procedure in the study required ICU or mechanical ventilation, and no extended hypoxemia or death occurred.

Table 3 summarizes the types of procedures in FB. Lavage was performed frequently in the non-desaturated group (28.8% vs. 9.5%, p< 0.001). Other procedures and centrally located lung lesions were similar in both groups. The lung lesions of all patients who underwent EBUS were centrally located.

## DISCUSSION

The primary findings of this study indicated the basal $SpO_2$ and the amount of $O_2$ decline during the procedure both for FB and EBUS were associated with desaturation during the procedure. Besides, the duration of the procedure and accompanying metabolic diseases were associated with desaturation for EBUS, while for FB, it was male sex and advanced age.

Desaturation in bronchoscopic procedures is frequent. In addition, EBUS, which is revolutionary in the field of bronchoscopy in the last ten years, is widely used to diagnose mediastinal lesions and

**Table 1.** Demographic characteristics, comorbidities and laboratory of the study groups in flexible bronchoscopy and endobronchial ultrasound

| | Flexible Bronchoscopy (n= 146) | | | Endobronchial Ultrasound (n= 50) | | |
|---|---|---|---|---|---|---|
| | **Desaturated (n= 42)** | **Non-desaturated (n= 104)** | **p** | **Desaturated (n= 33)** | **Non-desaturated (n= 17)** | **p** |
| Characteristics | | | | | | |
| Age, years, median (Q1-Q3) | 62 (52-68) | 55 (44-65) | **0.05** | 61 (49-65) | 61 (45-69) | 0.76 |
| Sex, male, n (%) | 23 (54) | 20 (19.2) | **<0.001** | 20 (60) | 8 (47) | 0.36 |
| BMI, kg/m$^2$, median (Q1-Q3) | 23 (20-25) | 24 (21-27) | 0.2 | 25 (24-28) | 26 (24-30) | 0.78 |
| Pack-year, median (Q1-Q3) | 20 (0-46) | 20 (0-30) | 0.55 | 9 (0-35) | 1 (0-30) | 0.51 |
| Active smoking, n (%) | 17 (40.4) | 36 (34.6) | 0.5 | 11 (33.3) | 4 (23.5) | 0.47 |
| Heavy smoking, n (%) | 16 (38) | 38 (36.5) | 0.86 | 11 (33.3) | 4 (23.5) | 0.47 |
| Use acetylsalicylic acid, n (%) | 5 (11.9) | 11 (10.5) | 0.777 | 7 (21.2) | 2 (11.7) | 0.41 |
| Comorbid diseases | 32 (76.1) | 79 (75.9) | 0.97 | 24 (72.7) | 11 (64.7) | 0.55 |
| Hypertension, n (%) | 15 (35.7) | 31 (29.8) | 0.48 | 14 (42.4) | 2 (11.7) | **0.02** |
| Diabetes mellitus, n (%) | 7 (16.6) | 23 (22.1) | 0.46 | 7 (21.2) | 0 | **0.04** |
| Congestive heart failure, n (%) | 1 (2.3) | 8 (7.6) | 0.44 | 1 (3) | 2 (11.7) | 0.21 |
| Ischemic heart, n (%) disease | 5 (11.9) | 19 (18.2) | 0.34 | 5 (15.1) | 3 (17.6) | 0.82 |
| Arrhythmia, n (%) | 2 (4.7) | 7 (6.7) | 1 | 2 (6) | 1 (5.8) | 0.98 |
| Chronic renal disease, n (%) | 2 (4.7) | 4 (3.8) | 0.8 | 3 (9) | 0 | 0.2 |
| COPD, n (%) | 7 (16.6) | 12 (11.5) | 0.4 | 1 (3) | 0 | 0.46 |
| Asthma, n (%) | 4 (9.5) | 6 (5.7) | 0.47 | 4 (12.1) | 0 | 0.13 |
| Bronchiectasis, n (%) | 1 (2.3) | 3 (2.8) | 0.86 | - | - | |
| OHS, n (%) | 0 | 1 (0.9) | 0.52 | 1 (3) | 0 | 0.46 |
| OSAS, n (%) | 1 (2.3) | 2 (1.9) | 0.86 | 1 (3) | 0 | 0.46 |
| ILD, n (%) | 0 | 3 (2.8) | 0.26 | - | - | |
| Systemic Disease, n (%) | 5 (11.9) | 7 (6.7) | 0.3 | 2 (6) | 0 | 0.3 |
| Thyroid disease, n (%) | 5 (11.9) | 7 (6.7) | 0.3 | 10 (30.3) | 0 | **0.01** |
| Malignancy, n (%) | 12 (28.5) | 30 (28.8) | 0.97 | 17 (51.5) | 9 (52.9) | 0.92 |
| Panic attack, n (%) | 4 (14.8) | 8 (8.9) | 0.38 | 1 (4.1) | 0 | 0.43 |
| Laboratory | | | | | | |
| Leukocyte count, $10^9$ L, median (Q1-Q3) | 8.2 (6.8-12.5) | 7.3 (5.7-9.8) | 0.06 | 6.8 (5.5-9.7) | 9.4 (7-13.4) | 0.08 |
| Hemoglobin, g/dL, median (Q1-Q3) | 12.6 (10.2-14.2) | 13.2 (10.5-14.6) | 0.3 | 13.2 (11.5-14.2) | 13.3 (11-14.5) | 0.86 |
| Platelet count, $10^9$ L, median (Q1-Q3) | 271 (213-377) | 239 (164-282) | **0.01** | 268 (199-324) | 278 (228-336) | 0.41 |
| INR, median (Q1-Q3) | 1 (0.9-1.1) | 1 (0.9-1.1) | 0.18 | 0.9 (0.9-1) | 1 (0.9-1.05) | 0.08 |

BMI: Body mass index, COPD: Chronic obstructive pulmonary disease, OHS: Obesity hypoventilation syndrome, OSAS: Obstructive sleep apnea syndrome, ILD: Interstitial lung disease, INR: International normalized ratio.

hilar lymph nodes. Desaturation is one of the most common (7.1%) complications during EBUS (9).

The findings regarding the relation of desaturation with basal saturation and the amount of $SpO_2$ decline are limited and variable. Fang et al. have conducted a study on patients who underwent FB indicated that basal $SpO_2$ was not associated with desaturation. The amount of $SpO_2$ decline was higher in patients who had desaturation (5). However, Sazak et al. have reported that basal $SpO_2$ level was an independent indicator for desaturation in patients who underwent EBUS (9). Our findings that show the relation of basal $SpO_2$ and the amount of $SpO_2$ decline with the development of desaturation in both

**Table 2.** Bronchoscopic data of the study groups in flexible bronchoscopy and endobronchial ultrasound

| | Flexible Bronchoscopy | | | Endobronchial Ultrasound | | |
|---|---|---|---|---|---|---|
| | Desaturated (n= 42) | Non-desaturated (n= 104) | p | Desaturated (n= 33) | Non-desaturated (n= 17) | p |
| SBP before the procedure, median (Q1-Q3) | 133 (128-157) | 130 (119-143) | 0.08 | 140 (122-160) | 130 (123-158) | 0.9 |
| DBP before the procedure, median (Q1-Q3) | 86 (77-100) | 83 (76-92) | 0.35 | 83 (80-98) | 80 (78-95) | 0.59 |
| Anxiety expressed before procedure, n (%) | 12 (44.4) | 28 (30.7) | 0.18 | 2 (8.3) | 7 (46.6) | **0.01** |
| Hypertension before procedure, n (%) | 14 (33.3) | 29 (27.8) | 0.51 | 16 (48.4) | 5 (29.4) | 0.19 |
| Route of administration | | | | | | |
| Nasal, n (%) | 32 (76.1) | 87 (83.6) | | 5 (15.1) | 1 (5.8) | |
| Oral, n (%) | 10 (23.8) | 17 (16.3) | 0.29 | 28 (84.8) | 16 (94.1) | 0.65 |
| Duration of the procedure, minute, median (Q1-Q3) | 13.5 (7-20) | 15 (8-21) | 0.51 | 40 (33-50) | 30 (22-33) | **<0.001** |
| Sedative agents, n (%) | 16 (38) | 24 (23) | 0.06 | 33 (100) | 16 (94.1) | 0.34 |
| Midazolam | 15 (38) | 24 (23) | 0.118 | 33 (100) | 16 (94.1) | 0.34 |
| Propofol | - | - | | 27 (81.8) | 10 (58.8) | 0.09 |
| Events during the procedure, n (%) | | | | | | |
| Hypertension | 20 (47.6) | 35 (33.6) | 0.11 | 12 (36.3) | 6 (35.2) | 0.94 |
| Presence of hemorrhage | 22 (52.3) | 51 (49) | 0.71 | 31 (93.9) | 14 (82.3) | 0.19 |
| Minor hemorrhage | 20 (47.5) | 48 (46.1) | 0.87 | 31 (93.9) | 14 (82.3) | 0.19 |
| Major hemorrhage | 2 (4.7) | 0 | **0.02** | - | - | |
| Tachycardia | 26 (61.9) | 57 (54.8) | 0.43 | 10 (30.3) | 4(23.5) | 0.61 |
| Arrhythmia | 1 (2.3) | 0 | 0.288 | 1 (3) | 0 | 0.46 |
| Endobronchial lesion, n (%) | 18 (42.8) | 39(37.5) | 0.54 | 2 (6) | 0 | 0.3 |
| $SpO_2$ % | | | | | | |
| Baseline, median (Q1-Q3) | 96 (93-98) | 98 (97-99) | **<0.001** | 97 (96-98) | 98 (98-98.5) | **0.01** |
| Lowest during procedure, median (Q1-Q3) | 85 (80-88) | 96 (94-97) | **<0.001** | 79 (71-84) | 95 (91-98) | **<0.001** |
| Change during pocedure, median (Q1-Q3) | 11 (7-14) | 1 (0-3.7) | **<0.001** | 18 (12-28) | 3 (0-7) | **<0.001** |
| Oxygen supplementation durign procedure, L/min, median (Q1-Q3) | 10 (6-15) | 6 (5-8) | **0.05** | 15 (8.5-15) | 10 (7-15) | 0.07 |

SBP: Systolic blood pressure, DBP: Diastolic blood pressure, BMI: Body mass index, COPD: Chronic obstructive pulmonary disease, OHS: Obesity hypoventilation syndrome, OSAS: Obstructive sleep apnea syndrome, ILD: Interstitial lung disease, INR: Internationl normalized ratio.

procedures emphasize the importance of these parameters.

In our study, while the length of the procedure in FB had no relation with desaturation, this relationship in EBUS may be associated with the sedation requirement being more profound, more tendency to desaturation, and longer mean procedure time in EBUS than FB. There is a lack of studies addressing the duration of the procedures regarding desaturation, and the reported results are conflicting. In the study of Sazak et al. in 571 EBUS subjects, it was presented that the length of the procedure showed no correlation with any complication, including desaturation (9). Likewise, Maranetra et al. have reported desaturation was not related to the decline of $SpO_2$ in FB, which agreed with our observation (10). It is suggested that the differences between these studies and our findings arise from subjects who underwent only diagnostic procedures, use of different anesthetic combinations, and the shorter median procedure time. On the other hand, Putra et al. have claimed that the length of procedure in FB was associated with hypoxemia (11). May et al. have also shown in their studies covering both approaches (FB and EBUS) that the duration of the procedure, basal $O_2$, and amount of oxygen support were determinants in developing respiratory complications during bronchoscopy (12).

Despite some reports to the contrary, we determined that desaturation was more frequent in elders and in males who underwent FB. Some authors have presented the relation of gender and age with desaturation in their studies (5,11,12).

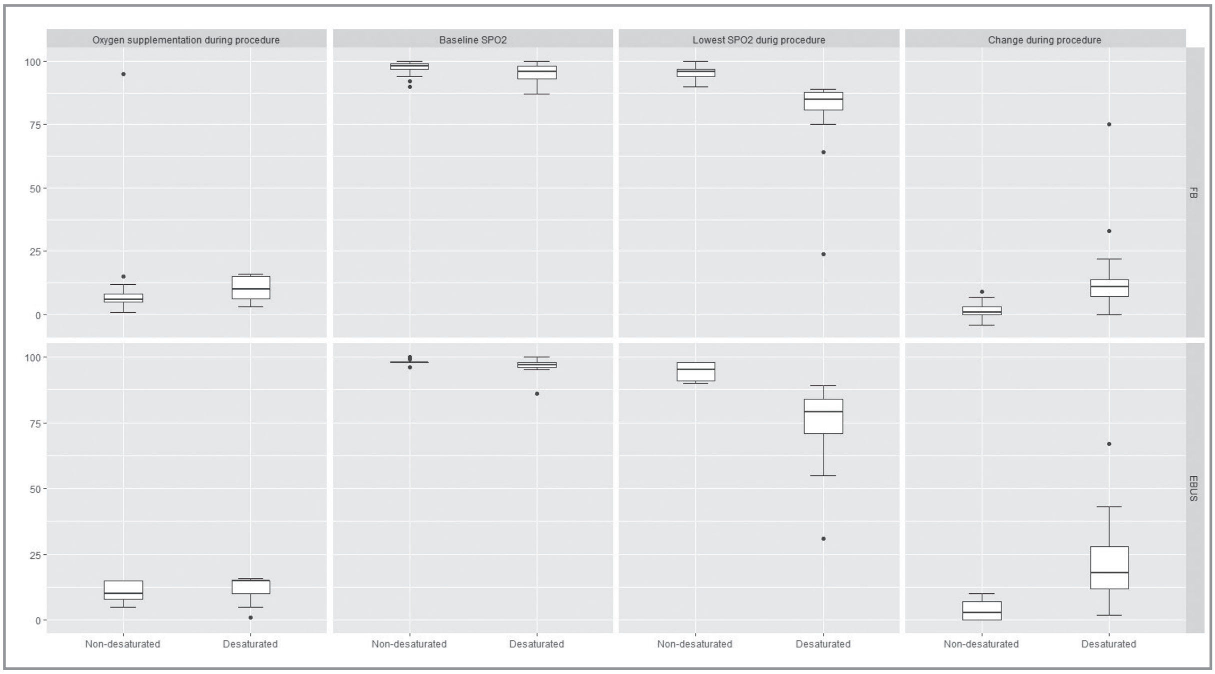


**Figure 2.** Plot graph of $sPO_2$ data of the study groups in Flexible bronchocsopy and Endobronchial ultrasound.

**Table 3.** Used types of procedures in flexible bronchoscopy

| | Flexible Bronchoscopy | | |
|---|---|---|---|
| **Bronchoscopic procedures, n (%)** | **Desaturated (n= 146)** | **Non-desaturated (n= 50)** | **p** |
| Observation | 5 (11.9) | 12 (11.5) | 0.33 |
| Lavage | 4 (9.5) | 30 (28.8) | **<0.001** |
| Forceps biopsy | 18 (42.8) | 37 (35.5) | 0.31 |
| Bronchoalveolar lavage | 10 (23.8) | 27 (25.9) | 0.09 |
| Transbronchial needle aspiration biopsy | 6 (14.2) | 13 (12.5) | 0.52 |
| Foreign body aspiration | 2 (4.7) | 1 (0.9) | 0.55 |
| Brushing | 0 | 3 (2.8) | 0.28 |
| Location of lung lesion central | 25 (59.5) | 46 (44.2) | 0.09 |

Although propofol and midazolam, which are the most frequently used sedatives for fiberoptic bronchoscopy and EBUS, are advantageous and safe agents with quick and short action, they have cardiac side effects and risk developing upper airway collapse and desaturation associated with diminished ventilation. In our study, neither the administration of sedation nor the agents administered had a relation with desaturation. This finding agrees with the previous studies and reflects a suitable anesthesia method (13). The hormonal and metabolic side effects of these agents seen in high doses are rare in low doses administered for bronchoscopy (14). However, in our study, the relation of desaturation with hypertension, diabetes mellitus, and thyroid diseases may indicate that sedative agents lower the respiratory side effect threshold. This result suggests that the underlying metabolic disorders increase the tendency of desaturation development in EBUS with sedation effect. Thus, it was concluded with the previous studies that the presence of any comorbidity does not directly affect the complication but the outcomes of the difficulties (13). However, as far as we know, there are no precise data regarding the relation of desaturation with the underlying metabolic diseases by analyzing the comorbidities at the level of disease groups.

Another factor that is important for desaturation is the patient's position during the procedure. While Mirci et al. have observed that there was more desaturation in the supine position, Zwam et al. have shown that the sitting part was a significant risk factor with 2.46 times more risk for oxygen decline than supine position, and they emphasized that supine position was effective and safe (15,16). Since all patients in this study were positioned supine, we could not have a chance to examine the effect of the position on desaturation.

The type of procedure performed is a crucial factor for desaturation. In a multi-center study where 20.986 bronchoscopies were evaluated, it was reported that desaturation most frequently developed during bronchoalveolar lavage (BAL) 26% and transbronchial biopsy (TBB) 18% (17). In the study of Fang et al., the most critical factors for desaturation during the procedure have been found as the types of procedures conducted ([lavage (88.9%), washing (43.8%), brushing (15.2%) and biopsy (10%)]) (5). In our study, EBUS was evaluated separately due to the different devices and who experienced technical equipment (anesthesia, device, ultrasound), and all those who underwent EBUS had a TBNA procedure. We determined that most of the subjects who experienced desaturation during FB had forceps biopsy (42.8%) and BAL (23.8%). No significant desaturation developed with shorter lavage procedures compared to other systems. The data available for the procedures conducted did not include the amount of liquid used and the specific amount of time, and the technique, 100-300 ml liquid, was recommended for BAL (18,19). In our practice, we use sterile saline with an amount varying between 5-10 mL for short lavage and 100-200 mL for BAL. Although our findings suggest differently from the previous studies because they are affected by factors such as techniques used, the amount of liquid used in BAL indicates that short lavage is safer in terms of desaturation.

The study's limitations were the small sample size, and retrospective nature, the failure to obtain data of onset and duration of desaturation.

## CONCLUSION

This study suggested that in both FB and EBUS, baseline $SpO_2$ and change of $SpO_2$ during the procedures, and in FB; sex, in EBUS; concomitant conditions, duration of procedure were related factors with desaturation in patients underwent bronchoscopic procedures. The proper evaluation of these factors and the management of the procedure accordingly before and during bronchoscopy may help avoid desaturation.

**Ethical Committee Approval:** The Hacettepe University ethics committee approved this study. (Ankara-Turkey-05.05.2020-No: GO 20/413). Ethical approval was in accordance with the Declaration of Helsinki.

## CONFLICT of INTEREST

The authors have no conflicts of interest, including specific financial interests, relationships, and/or affiliations relevant to the subject matter or materials included.

## AUTHORSHIP CONTRIBUTIONS

Concept/Design: İI, ZTS, LÇ

Analysis/Interpretation: İI, ZTS

Data Acqusition: İI, FT

Writing: İI, ZTS, FT, LÇ

Clinical Revision: İI, ZTS, LÇ

Final Approval: İI, ZTS, LÇ, FT

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