HOKKAIDO UNIVERSITY

Title	Susceptibility to oxygen desaturation during bronchoscopy in elderly patients with pulmonary fibrosis
Author(s)	Shinagawa, Naofumi; Yamazaki, Koichi; Kinoshita, Ichiro et al.
Citation	Respiration, 73(1), 90-94 https://doi.org/10.1159/000088093
Issue Date	2006-02
Doc URL	https://hdl.handle.net/2115/17180
Rights	© 2006, S. Karger AG, Basel
Type	journal article
File Information	RESPIRATION73-1.pdf

Hokkaido University Collection of Scholarly and Academic Papers : HUSCAP

Susceptibility to Oxygen Desaturation During Bronchoscopy in Elderly Patients with Pulmonary Fibrosis

Naofumi Shinagawa[a], Koichi Yamazaki[a], Ichiro Kinoshita[b], Shigeaki Ogura[c], Masaharu Nishimura[a]

[a]First Department of Medicine, [b]Department of Medical Oncology, Hokkaido University School of Medicine, and [c]Department of Respiratory Disease, Sapporo City General Hospital, Sapporo, Japan.

Correspondence to: Koichi Yamazaki, MD, PhD,
First Department of Medicine, Hokkaido University School of Medicine, North 15, West 7, Kitaku, Sapporo 060-8638, Japan
E-mail: kyamazak@med.hokudai.ac.jp
Fax: +81-11-706-7899
Phone: +81-11-706-5911

Running Title: Desaturation during Bronchoscopy

Key words:

Bronchoscopy; oxygen desaturation; pulmonary fibrosis; interstitial pneumonia

Abstract

***Background*:** Fiber-optic flexible bronchoscopy (FFB) is a frequently performed procedure for the diagnosis and treatment of pulmonary disorders. However, hypoxemia occasionally occurs during FFB.

Objectives: We attempted to examine the causes of arterial oxygen desaturation during FFB.

Methods: We studied 336 patients who underwent FFB without intervention between June 1, 2001 and September 30, 2002. Arterial oxygen saturation (SpO_2) was continuously monitored using oximetry with a recording system. We analyzed the relationship between a reduction in SpO_2 during FFB and various clinical parameters or background lung diseases.

Results: Of the 336 patients, 73 (22%) had an episode of oxygen desaturation (SpO_2 < 90 over 10 seconds). Of patients over 80 years old, 55% had an episode of oxygen desaturation, which was significantly higher than 27% observed in the patients of 80 and less than 80 years old ($P < 0.05$). Patients with pulmonary fibrosis had a higher risk of desaturation (55%),

compared to patients with other complications or patients without any complication ($P < 0.05$). Multivariable analysis revealed that both age and pulmonary fibrosis were independent predictors of oxygen desaturation. However, the majority of the patients (94%) did not require routine oxygen supplementation.

Conclusion: Although FFB is safe and does not require oxygen supplementation in most cases, age over 80 years and pulmonary fibrosis are high risk factors for significant oxygen desaturation during FFB.

Introduction

Fiber-optic flexible bronchoscopy (FFB) is a safe and frequently performed procedure for the diagnosis and treatment of pulmonary disorders. However, hypoxemia has been shown to occur during FFB procedures. Hypoxemia can occur by several mechanisms including oversedation, suctioning during the procedure, which can remove oxygen or decrease lung volumes below functional residual capacity, and increased ventilation-perfusion mismatching by bronchospasm, bleeding, and instillation of fluids. Hypoxemia is one of the most dangerous complications because it has the potential to cause cardiac arrhythmia [1].

Since the pulse oximeter became commercially available, monitoring of oxygen saturation during procedures has become routine in most institutions. The British Thoracic Society recommends that patients should be monitored by oximetry and that oxygen supplementation should be administered as necessary to achieve an oxygen saturation of at least 90% to reduce the risk

of significant arrhythmias during the procedure and also in the postoperative recovery period.

Patients with complicating lung diseases such as asthma and chronic obstructive pulmonary disease (COPD) have increased risks of oxygen desaturation during FFB [2]. However, Jones *et al.* argued that the majority of patients, especially those with a forced expiratory volume in one second (FEV1) above 1 L, did not require routine oxygen supplementation [3].

In the present study, we evaluated the arterial oxygen saturation (SpO_2) of patients during the FFB procedure without interventions and analyzed the relationship between oxygen desaturation and spirometric parameters or complicating lung diseases.

Materials and Methods

Subjects and study design

At Hokkaido University Hospital, 336 patients underwent screening FFB without intervention between June 1, 2001 and September 30, 2002. These

patients were 231 men and 105 women with an average age of 62.1 years (range, 18 to 87 years). Approximately 90% of these patients underwent FFB because of localized pulmonary lesions or hemoptysis. Of these 336 patients, 257 underwent a spirogram within 3 weeks before or after bronchoscopy. However, we excluded the pulmonary function test (PFT) data of those patients who may have had their PFT data altered by the FFB procedure, such as those with bronchial asthma and atelectasis.

The data included slow vital capacity (VC), %VC, FEV1, FEV1/forced vital capacity (FVC), functional residual capacity (FRC), %FRC, diffusing capacity for carbon monoxide (DLco), %DLco, DLco/alveolar volume (DLco/VA), and %DLco/ VA.

Complicating lung diseases such as COPD [4,5], asthma, pulmonary fibrosis [6-8], sarcoidosis, post-lobectomy, atelectasis, and pneumoconiosis were also reviewed from the patients' medical records retrospectively.

Chronic obstructive pulmonary disease was diagnosed following the GOLD guideline [9]. The diagnosis of pulmonary fibrosis was based on chest

computed tomography (CT) findings, which were characterized by ground-glass opacities, linear interstitial opacities, coarse reticular-nodular shadows, and honeycombing. We used a multidetector CT scanner (Aquilion Multi 4-detector, Toshiba, Tokyo, Japan) for all CT examinations. Conventional whole lung CT images were acquired of 5-mm thick sections. If complicating lung diseases were suspected from conventional CT images, high resolution CT (HRCT) with 1.0-mm thick sections was performed for those lesions. The HRCT parameters were as follows: 1.0 mm collimation, 135 – 149 kVp, 100 mA, rotation time 1.0 sec .

The differential diagnoses included idiopathic pulmonary fibrosis (IPF), nonspecific interstitial pneumonia (NSIP), IPF associated with collagen vascular disease (CVD), farmer's lung, and other idiopathic interstitial pneumonias (IIPs). Sarcoidosis was diagnosed according to the ATS guidelines [10].

Fiber-optic flexible bronchoscopy

In our unit, supplemental oxygen is not routinely given to the patients undergoing FFB. If, however, there was a sustained fall in oxygen saturation during the procedure (i.e., < 90% for 30 sec or < 80% immediately), supplemental oxygen was administered nasally at a flow rate between 2 and 5 L/min to maintain SpO_2 > 90%. Lidocaine was given for local anesthesia to all patients. Pentazocine (15 mg) and atropine sulfate (0.5 mg) were administered intramuscularly. Fiber-optic flexible bronchoscopy procedures were performed by seven pulmonary fellows who each had more than 5 years of FFB training and who were directly supervised and assisted by the pulmonary faculty in attendance.

Monitoring of arterial oxygen saturation during fiber-optic flexible bronchoscopy

Arterial oxygen saturation (SpO_2) was continuously monitored using oximetry with a finger probe (PULSOX-5™; Konica Minolta Holdings, Inc.,

Tokyo, Japan). The data were recorded, stored, and later analyzed using PULSOX SpO_2 Analysis Version 2.0a™ software (Stowood Scientific Instruments, Oxford, UK). Total examination time, average SpO_2, duration of $SpO_2 < 90$, duration of $SpO_2 < 80$, and minimum SpO_2 were measured. The total examination time was the period between the insertion of the bronchoscope and the end of the fluoroscopic screening (not including transbronchial biopsy and bronchoalveolar lavage). Oxygen desaturation was defined to be present when $SpO_2 < 90$ continued more than 10 seconds.

Statistical analysis

All data were processed using standard statistical methods with StatView™ version 5.0 software (SAS Institute Inc., Cary, NC, USA). Results were presented as mean ± standard deviation (SD). Two by two frequency tables and the Pearson's correlation coefficient test were used to estimate the relationship between the values obtained in spirometry tests and SpO_2. Logistic regression analysis was applied for multivariable analysis of risk

factors for desaturation. A p value of < 0.05 was regarded as significant.

Results

All FFB examinations were performed without any complications. The average total time of screening FFB without intervention was 9.7 min. Of the 336 patients, 73 patients (22%) had an episode of desaturation (SpO_2 < 90% over 10 seconds) during FFB procedures. Among them, 19 patients (6%) required oxygen supplementation.

First, we analyzed the association between percentages of SpO_2 < 90 and age. Of the patients over 80 years old, 55% had an episode of SpO_2 < 90 (compared to patients of 80 and less than 80 years old, 27%, p < 0.05) and oxygen supplementation was required for 18% of patients over 80 years old (compared to patients of 80 and less than 80 years old, 5%, p = 0.067). However, there were no statistical relationships between oxygen desaturation and various clinical parameters (height, weight, body mass

index (BMI), VC, %VC, FEV1, FEV1/FVC, FRC, %FRC, DLco, %DLco, DLco/VA, and %DLco/VA). Patients with a FEV1 ≦ 1.0 l had a higher risk of oxygen desaturation compared to those with a FEV1 > 1.0 l, but the difference was not significant (50% vs. 24%, p = 0.056). There was no significant relationship between oxygen desaturation and arterial oxygen saturation at rest.

We next examined the association between oxygen desaturation and the presence of complicating lung disease (Table 1). Among several complicating lung disorders, pulmonary fibrosis was the highest risk factor for oxygen desaturation. Of the patients with pulmonary fibrosis, 55% had an episode of oxygen desaturation, significantly higher than patients with other complicating lung diseases or no complications ($P < 0.05$). There were no significant differences in age, FEV1, or other various clinical parameters (height, weight, BMI, VC, %VC, FEV1/FVC, FRC, %FRC, DLco, %DLco, DLco/VA, and %DLco/VA) between patients with pulmonary fibrosis and other patients. However, elderly patients with pulmonary fibrosis seemed to

have a higher risk of oxygen desaturation. Among four patients over 75 years old with pulmonary fibrosis, three had an episode of oxygen desaturation (Table 2). The fourth patient, who was 81 years old, had an episode of oxygen desaturation for a total of 280 seconds during FFB and needed oxygen supplementation.

Multivariate analysis revealed that age (over 80 years old) and the presence of pulmonary fibrosis were independent predictors of oxygen desaturation (Table 3).

Discussion

In the present study, we analyzed the relationship between oxygen desaturation during FFB and various clinical parameters or complicating lung diseases. As a result, age and pulmonary fibrosis were identified as significant risk factors of oxygen desaturation. Although the number of patients might be small, this is the first report to suggest the association

between pulmonary fibrosis and oxygen desaturation during FFB.

As one of the mechanisms accounting for hypoxemia in patients with pulmonary fibrosis, low functional residual capacity (FRC) should be considered. However, in the present study, there was no significant difference between the level of FRC in patients with pulmonary fibrosis and that of the other patients (data not shown). On the other hand, it was reported that FRC increased during the FFB examination by the augmentation of airway resistance from FFB insertion [11]. Moreover, it was speculated that increased FRC maintained airway patency and prevented decreases in SpO_2. However, FRC might not increase in the case of pulmonary fibrosis compared to other complicating diseases because of low lung compliance by the fibrosis, although we did not examine FRC during FFB in the present study.

The British Thoracic Society guidelines recommend checking the spirometric parameters of patients with suspected COPD before FFB, and if the COPD is found to be severe (FEV1 < 40% or SpO_2 < 93%), the patients should have

arterial blood gas tensions measured. Oxygen supplementation may lead to an increase in the arterial PCO_2 level; in cases in which the pre-bronchoscopy arterial PCO_2 is raised, oxygen supplementation should be given with extreme caution. Other conditions that may complicate FFB are asthma, advanced patient age, a history of myocardial infarction, raised intracranial pressure, and hemoptysis [2]. However, pulmonary fibrosis has not been proposed as a high-risk disease of oxygen desaturation during FFB procedures. The precise reason is not clear, perhaps due to the difficulty in diagnosing pulmonary fibrosis. Pulmonary fibrosis includes a wide spectrum of pulmonary abnormalities and inflammatory diseases of the pulmonary interstitium. In this study, when we defined pulmonary fibrosis only from chest CT findings, the relationship between oxygen desaturation during FFB and pulmonary fibrosis emerged.

A number of studies have shown a high incidence of lung cancer in patients with idiopathic pulmonary fibrosis compared to control subjects [12, 13]. Patients with pulmonary fibrosis should frequently receive FFB and thus,

should receive closer attention regarding oxygen desaturation during FFB.

Supplemental oxygen is given to all patients during FFB in some institutes [14, 15]. However, the data in the present study indicated that the majority of our patients (94%) did not require routine oxygen supplementation, supporting the findings of Jones and colleagues [3].

In conclusion, although FFB is generally safe without oxygen supplement, age (over 80 years old) and pulmonary fibrosis are two high risk factors for oxygen desaturation during FFB.

References

1. Shrader DL, Lakshminarayan S. The effect of fiber-optic bronchoscopy on cardiac rhythm. Chest 1978; 73:821-824

2. British Thoracic Society guidelines on diagnostic flexible bronchoscopy. Thorax 2001; 56:i1-i21

3. Jones AM, O'Driscoll R. Do all patients require supplemental oxygen during flexible bronchoscopy? Chest 2000; 119:1906-1909

4. Viege G, Scognamiglio A, Baldacci S, Pistelli F, Carrozzi L. Epidemiology of chronic obstructive pulmonary disease (COPD). Respiration 2001; 68:4-19

5. Kornmann O, Beeh KM, Beier J, Geis UP, Ksoll M, Buhl R. Newly diagnosed chronic obstructive pulmonary disease. Respiration 2003; 70: 67-75

6. Boros PW, Franczuk M, Wesolowski S. Value of spirometry in detecting volume restriction in interstitial lung disease patients. Respiration 2004;

71:374-379

7. Chetta A, Marangio E, Olivieri D. Pulmonary function testing in interstitial lung diseases. Respiration 2004; 71:209-213

8. Nagano T, Nagai S, Hiramoto Y, Hamada K, Shigematsu M, Hayashi M, Izumi T, Mishima M. Serial evaluation of high-resolution computed tomography findings in patients with idiopathic pulmonary fibrosis in usual interstitial pneumonia. Respiration 2002; 69:413-419

9. National Institute of Health, National Heart Lung and Blood Institute (NHLBI). *Global strategy for the diagnosis, management, and prevention of chronic obstructive pulmonary disease.* Based on April 1998 NHLBI/WHO Workshop, April 2001 (updated 2003).

10. Statement on sarcoidosis. Joint Statement of the American Thoracic Society (ATS), the European Respiratory Society (ERS) and the World Association of Sarcoidosis and Other Granulomatous Disorders (WASOG) adopted by the ATS Board of Directors and by the ERS Executive Committee, February 1999. Am J Respir Crit Care Med. 1999;

160:736-755

11. Matsushima Y, Jones RL, King EG, Moysa G, Alton JDM. Alternations in the pulmonary mechanics and gas exchange during routine fiberoptic bronchoscopy. Chest 1984; 86:184-188

12. Mizushima Y, Kobayashi M. Clinical characteristics of synchronous multiple lung cancer associated with idiopathic pulmonary fibrosis. Chest 1995; 108:1272-1277

13. Bouros D, Hazakis K, Labrakis H, Zeibecoglou K. Association of malignancy with diseases causing interstitial pulmonary change. Chest 2002; 121:1278-1289

14. Milman N, Faurschou P, Grode G, Jorgensen A. Pulse oximetry during fiber-optic bronchoscopy in local anaesthesia: Frequency of hypoxaemia and effect of oxygen supplementation. Respiration 1994; 61:342-347

15. McCain TW, Dunagan DP, Adair NE, Chin RJ. Prospective randomized trial comparing oxygen administration during nasal flexible bronchoscopy. Chest 2001; 120:1671-1674

Table 1. Complicated lung disease and $SpO_2 < 90$

	No.	Age (years)*	FEV_1 (l)*	No. (%) of $SpO_2 < 90$†
Complications				
COPD	59	68.0 ±8.9	2.00 ± 0.71	15(25%)
Sarcoidosis	23	44.7 ±18.8	2.65 ± 0.71	6(26%)
Pulmonary fibrosis	18	67.8 ± 7.8	2.05 ± 0.59	10(56%) ‡
Post-lobectomy	16	61.4 ±12.8	1.79 ± 0.60	1(6%)
Atelectasis	15	65.9 ± 8.6	1.78 ± 0.54	3(20%)
Others §	48	60.5 ± 18.2	2.26 ± 0.60	8(17%)
No complication	157	61.8 ±12.9	2.42 ± 0.68	44(28%)

* Mean ± SD.

† Number of patients who had $SpO_2 < 90$ over 10 second during FFB.

‡ $P < 0.05$ compared with no complication.

§ included patients with bronchial asthma, pneumoconiosis, old pulmonary tuberculosis, etc.

Table 2. Characteristics of the patients with pulmonary fibrosis

Age (year)	Sex	Clinical Diagnosis	VC (l)	%VC (%)	FEV_1 (l)	FRC (l)	%DLco (%)	%DLco/V_A (%)	SpO_2<90 (sec)	SpO_2 (%) at rest	O_2 Supply
Lower than 75 years old											
52	F	IIPs	2.16	88.5	1.93	1.81	62.2	95.3	0	95.9	
52	F	IP associated with CVD	1.75	72.3	1.46	1.83	32.0	43.7	0	95.2	
59	M	IIPs	3.22	97.6	2.26	N.D.	86.6	81.3	0	95.1	
63	M	IIPs	4.29	128.8	3.26	3.98	87.6	71.3	10	96.7	
63	M	IIPs	2.94	89.1	2.59	2.21	73.4	85.7	10	96.0	
64	M	IIPs	2.66	83.6	2.60	3.38	63.0	45.7	0	98.5	
65	M	IIPs	3.94	122.7	2.82	N.D.	76.8	63.9	40	95.6	
67	M	IIPs	4.25	127.2	3.23	4.73	63.5	43.6	0	96.8	
68	M	IIPs	2.71	83.4	1.62	N.D.	45.2	42.0	45	95.2	
68	M	IIPs	3.23	97.9	2.22	3.11	63.5	49.6	70	97.3	
68	M	IIPs	3.19	97.9	2.70	3.43	82.2	69.6	0	97.2	
69	M	IPF	2.98	95.8	2.50	3.31	63.1	58.2	15	97.7	
71	M	NSIP	1.70	53.0	1.54	1.79	33.5	61.8	95	95.9	
71	M	IIPs	2.84	91.6	2.31	N.D.	63.3	60.0	10	96.2	
71	M	Farmer's lung	4.14	119.0	2.93	3.29	63.3	49.3	0	95.2	
72	M	IIPs	1.84	56.8	1.52	3.34	119.1	110.0	0	94.9	
75 years old or higher											
75	F	Drug induced pneumonia	1.33	63.3	1.01	N.D.	43.6	74.4	30	94.7	
76	F	IP associated with CVD	1.67	68.2	1.43	1.51	40.6	70.8	0	94.9	
76	F	IIPs	1.76	86.7	1.25	N.D.	83.2	107.6	25	94.1	
81	M	IIPs	2.79	91.8	2.21	3.01	63.4	48.3	280	93.8	+

Abbrevations:IIPs; idiopathic interstitial pneumonias, IPF; idiopatic pulmonary fibrosis, NSIP; nonspecific interstitial pneumonia, CVD; collagen vascular disease, N.D.; not determined

Table 3. Multivariable analysis of features associated with $SpO_2 < 90$

Variable	Odds ratio	95% CI	*P* value
Age ＞ 80	5.68	1.54 to 20.96	0.009
Pulmonary Fibrosis	2.76	1.05 to 7.26	0.039