Original Article

Is Oxygen Supplementation Needed after Standard Pulmonary Resection for Primary Lung Cancer?

Tokujiro Yano, MD, Fumihiro Shoji, MD, and Tadashi Koga, MD

Objective: Theoretically, anatomical pulmonary resection does not cause any shunt effect, and thus it is thought that oxygen (O_2) supplementation is not necessary after a pulmonary lobectomy or pneumonectomy. Without O_2 supplementation, we have streamlined our postoperative management for pulmonary resection. In the present study, we prospectively assessed our perioperative management for both requirement of O_2 supplementation and postoperative complications.

Patients and Methods: From April 2003 to March 2005, 89 consecutive patients underwent a pulmonary lobectomy or pneumonectomy for primary lung cancer. Our protocol for perioperative care is as follows: [Preoperative] Smoking cessation longer than 2 weeks before surgery. [Intraoperative] Postero-lateral thoracotomy through the 5th or 6th rib bed. Cutting of the 5th or 6th intercostal nerve before closure of the wound. [Postoperative day (POD) 1] O_2 administration was discontinued in the morning. Ambulation without O_2 supplementation. [POD 2] Removal of an epidural catheter. During the postoperative period, percutaneous monitoring of O_2 saturation was continued.

Results: The mean postoperative O_2 saturation of those 89 patients was 97.0% on the POD 1, 96.4% on the POD 2, 96.6% on the POD 3, and 97.5% on the POD 7. Only 3 patients required O_2 therapy after discontinuation of O_2 administration due to non-lethal pulmonary embolism. Depending on the duration of smoking cessation prior to operation, the patients were divided into 4 groups (2 weeks >, 1 month >, 1 month ≤, and nonsmokers). Neither the incidence of postoperative complications nor the length of postoperative hospital stay was different among those 4 groups.

Conclusion: It is suggested that the postoperative O_2 supplementation is not routinely necessary. (Ann Thorac Cardiovasc Surg 2006; 12: 393–6)

Key words: surgery, pulmonary lobectomy, perioperative care, smoking, complication

Introduction

Theoretically, anatomical pulmonary resection does not cause any shunt effect. It is thus thought that oxygen (O_2) supplementation is not necessary after a pulmonary lobectomy or pneumonectomy, the standard operation for primary lung cancer. Unnecessary O_2 supplementation limits the patients mobility, and is likely to cause pulmonary morbidity, i.e., atelectasis, pneumonia, and pulmonary embolism. Based on these findings, we have streamlined our postoperative management for pulmonary resection without O_2 supplementation.

In the present study, we prospectively assessed 89 consecutive patients for both requirement of O_2 therapy and complications, and investigated the precise postoperative management without O_2 supplementation.

From the Department of Surgery, Saga Prefectural Hospital KOSEIKAN, Saga, Japan

Received February 10, 2006; accepted for publication May 23, 2006.

Address reprint requests to Tokujiro Yano, MD: the Department of Surgery, Saga Prefectural Hospital KOSEIKAN, 1–12–9 Mizugae, Saga 840–8571, Japan.

Patients and Methods

Patient selection and study design

Between April 2003 and March 2005 we prospectively followed 89 consecutive patients, who underwent either pulmonary lobectomy (85 patients) or pneumonectomy (4 patients) for primary lung cancer. The primary selection of eligible patients for major pulmonary resection was based on the spirometry data. The minimal requirements for performing either lobectomy or pneumonectomy were both more than 600 ml/m^2 of predicted postoperative vital capacity and more than 400 ml/m^2 of predicted postoperative forced expiratory volume in one second ($FEV_{1.0}$), which were calculated using the preoperative spirometric data, a radiological study of pulmonary perfusion and information on the number of removed segments.

Our protocol for perioperative care is as follows:

[Preoperative] Patients were advised to quit smoking for longer than 2 weeks before surgery. They were trained to excrete sputum by nebulization with bronchodilators.

[Intraoperative] In order to prevent deep vein thrombosis, graduated compression stockings and external pneumatic compression were utilized in all patients. Postero-lateral thoracotomy was done through the 5th or 6th rib bed. The 5th or 6th intercostal nerve was cut before closure of the thoracotomy wound for prevention of intercostal neuralgia. Patients who had 2 or more risk factors of postoperative interstitial pneumonia were intravenously given 125 mg of methylprednisolone just before the thoracotomy.[1)] The risk factors included male gender, Brinkman index >400, and the presence of interstitial changes on chest computed tomography (CT).

[Postoperative day (POD) 1] In the morning, O_2 administration was discontinued and the urinary catheter was removed. Patients walked to the lavatory by themselves without O_2 supplementation.

[POD 2] The epidural catheter was removed. During the postoperative period, percutaneously monitoring of O_2 saturation was continued on ambulation. When the O_2 saturation was lower than 90%, O_2 therapy was carried out again.

The protocol for our perioperative management was approved by the Institutional Review Board, and a written informed consent form was obtained from all the patients on admission.

Statistics

A statistical analysis (comparison among 4 groups) was performed using an analysis of variance (ANOVA). When the ANOVA showed that a comparison was statistically significant, then individual pairs of comparison were made using the Fisher's and Scheff's tests. All results were considered significant at p values being <0.05.

Results

Treatment summary

The mean postoperative O_2 saturation of all the patients was 97.0% on POD 1, 96.4% on the POD 2, 96.6% on the POD 3, and 97.5% on the POD 7 (Fig. 1). Out of the 89 patients in the study, only 3 patients experienced hypoxia (O_2 saturation <90% under the room air) and required O_2 therapy again. All 3 patients were diagnosed with pulmonary embolism by either chest CT or pulmonary scintigram. All of those patients were successfully treated with an intravenous administration of heparin sodium alone.

Postoperative complications

Other than pulmonary embolism in 3 patients, postoperative complications occurred in 5 patients. These included pleuro-bronchial fistula in 1 patient, wound infection in 1 patient, and prolonged air-leakage longer than a week in 3 patients. Preoperative smoking is a well-known risk factor for postoperative complication, especially pulmonary events. Those 89 patients were therefore divided into 4 groups depending on the duration of smoking cessation prior to operation (2 weeks >, 1 month >, 1 month ≤, and nonsmokers). The number of patients in each group was 12, 14, 28 and 35, respectively. Preoperative profiles of these 4 groups are summarized in Table 1. All the preoperative factors (age, comorbidity, pulmonary function, body mass index (BMI), blood loss volume) showed no significant difference among the groups except for the nonsmoking group. Naturally, the nonsmoking group carried a lower risk than any other groups. However, the incidence of postoperative complications was not different among those 4 groups (4 postoperative complications in the '≥ 1 month' group and nonsmoking group, respectively). The length of postoperative hospital stay (time to discharge home) was similar among those 4 groups (Fig. 2).

Discussion

O_2 therapy is considered unnecessary after pulmonary resection with no shunt effect. Unnecessary O_2 administration on the bed will allow shallow breath and can be a

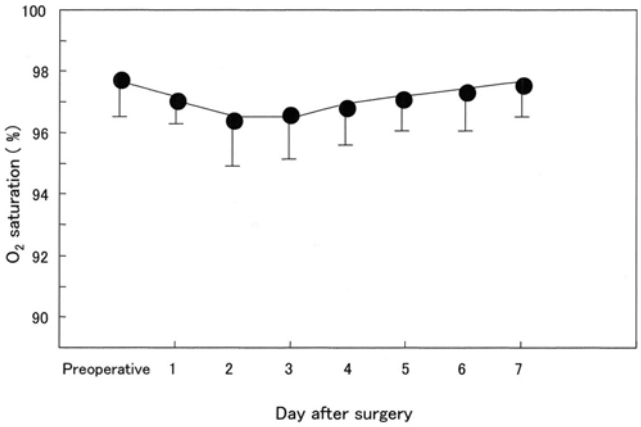

Fig. 1. Postoperative O_2 saturation under room air (n=89). Bars, standard deviations.

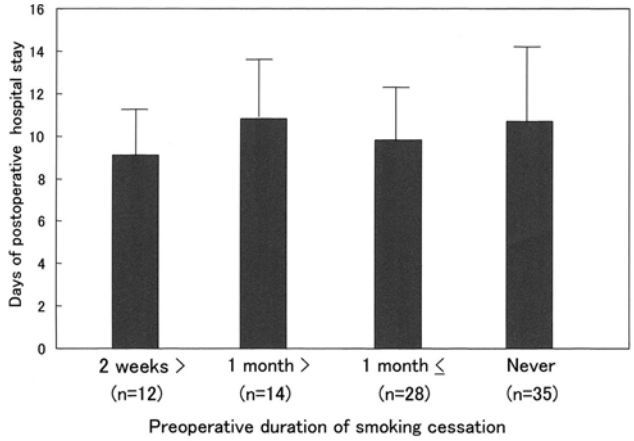

Fig. 2. Length of postoperative hospital stay according to the duration of smoking cessation (p=0.35). Bars, standard deviations.

Table 1. Preoperative profiles of the 4 groups divided according to the preoperative smoking status

	Preoperative duration of smoking cessation				
	2 weeks > (n=12)	1 month > (n=14)	1 month ≤ (n=28)	Never (n=35)	*p* value
Mean age	63.9	72.8	69.5	64.0	0.014
Comorbidity (%)	58.3	45.5	53.1	38.1	0.132
$FEV_{1.0\%}$	70.7	70.8	70.2	80.2	0.002
BMI	20.4	21.8	20.8	22.2	0.189
Blood loss volume (g)	163.8	233.1	171.6	194.9	0.568

$FEV_{1.0\%}$, percent forced expiratory volume in one second; BMI, body mass index.

cause of pulmonary morbidity. Furthermore, hyperoxia by O_2 therapy is considered to induce lung injury through increased production of reactive oxygen species.[1–3] The postoperative care without O_2 supplementation makes early ambulation easy, therefore resulting in prevention of microatelectasis and consequent hypoxia. The advent of a percutaneous O_2 saturation monitor has made ambulatory measurement of O_2 saturation easily possible. In this study, we clearly demonstrated that O_2 saturation of all but 3 patients was higher than 95% through the POD 1 to the POD 7 under the room air.

In addition, hypoxia or pulmonary complications, i.e., atelectasis, pulmonary embolism, and interstitial pneumonia can be detected earlier on room air as opposed to supplemental O_2 administration. In this study, 3 patients experienced hypoxia on the POD 1 or the POD 2, and were diagnosed as pulmonary embolism with a nonlethal mild grade. All those patients were successfully treated with urgent intravenous administration of anticoagulant (heparin sodium). It was ascribed to both the early ambulation (walking on the POD 1) and the early detection of hypoxia under the room air.

It is well known that preoperative smoking increases airway secretion both during and after any operation under general anesthesia, and is thus associated with the postoperative pulmonary complications.[4–6] Smoking also suggests a risk factor for surgical site infection.[7,8] Therefore, in order to clarify the advantage of our postoperative management without O_2 supplementation, we divided the patients into 4 groups depending on the preoperative smoking status, and compared postoperative morbidity. The preoperative nonsmoking period did not affect the incidence of postoperative morbidity. The results suggested that increased airway secretion due to pre-

operative smoking can be overwhelmed by early walking without O_2 administration on the following morning of the surgery.

In conclusion, O_2 supplementation is not only unnecessary after standard pulmonary resection but also masks hypoxia. Our postoperative management without O_2 supplementation might be adequate for standard pulmonary resection.

References

1. Yano T, Koga T. Prophylactic administration of methylprednisolone for interstitial pneumonia after pulmonary resection. *Jpn J Chest Surg* 2003; **17**: 640–3. (in Jpse.)
2. Jackson RM. Pulmonary oxygen toxicity. *Chest* 1985; **88**: 900–5.
3. Pagano A, Barazzone-Argiroffo C. Alveolar cell death in hyperoxia-induced lung injury. *Ann N Y Acad Sci* 2003; **1010**: 405–16.
4. Nakagawa M, Tanaka H, Tsukuma H, Kishi Y. Relationship between the duration of the preoperative smoke-free period and the incidence of postoperative pulmonary complications after pulmonary surgery. *Chest* 2001; **120**: 705–10.
5. Warner MA, Divertie MB, Tinker JH. Preoperative cessation of smoking and pulmonary complications in coronary artery bypass patients. *Anesthesiology* 1984; **60**: 380–3.
6. Vaporciyan AA, Merriman KW, Ece F, et al. Incidence of major pulmonary morbidity after pneumonectomy: association with timing of smoking cessation. *Ann Thorac Surg* 2002; **73**: 420–6.
7. Sorensen LT, Karlsmark T, Gottrup F. Abstinence from smoking reduces incisional wound infection: a randomized controlled trial. *Ann Surg* 2003; **238**: 1–5.
8. Mangram AJ, Horan TC, Pearson ML, Silver LC, Jarvis WR. Guideline for prevention of surgical site infection, 1999. Hospital Infection Control Practices Advisory Committee. *Infect Control Hosp Epidemiol* 1999; **20**: 250–80.