Original Article

Access this article online

Quick Response Code:

Website:
www.eurasianjpulmonol.com

DOI:
10.4103/ejop.ejop_8_18

Prediction of postoperative pulmonary complications in lung cancer surgery: Is proportion of emphysema important?

Tevfik Ilker Akcam, Seyda Ors Kaya[1], Onur Akcay[2], Ozgur Samancilar[1], Serpil Sevinc[1], Seher Susam[3], Kenan Can Ceylan[1]

Abstract

OBJECTIVE: Preoperative evaluation in thoracic surgery is highly important to determine surgical suitability, estimate postoperative pulmonary complications, and for patient follow-up. However, there is neither a definite explanation about the possible complications nor a gold standard method.

MATERIALS AND METHODS: In this study, 297 patients undergoing anatomic lung resection for primary lung carcinoma were retrospectively evaluated. To form a homogeneous group, all factors that increase the rate of pulmonary complication were excluded except emphysema. Patients who did not meet these criteria were removed from the study. The study continued with 104 other patients. This patient subgroup was divided into groups according to Goddard Classification– Score (GdCS). The correlation between GdCS and other variables was statistically investigated.

RESULTS: According to the GdCS of 104 patients, the patient distribution was as follows: 10 patients (9.6%) were G0, 28 patients (26.9%) were G1, 42 patients (40.4%) were G2, 22 patients (21.2%) were G3, and 2 patients (1.9%) were G4. Thirty-five (33.6%) of 104 patients had a pulmonary complication during the postoperative follow-up. The average drainage time was longer for higher GdCS scores, and the rate of exposition to a pulmonary complication was higher in the patients with increased GdCS.

CONCLUSION: In view of these findings, Goddard's scoring for chronic obstructive pulmonary disease-emphysema patients was considered likely to be an indicative parameter in the preoperative evaluation and postoperative follow-up of thoracic surgery patients.

Keywords:

Emphysema, Goddard classification, lung resection

Ege University School of Medicine, Department of Thoracic Surgery, [1]Dr. Suat Seren Chest Diseases and Thoracic Surgery Training and Research Hospital Department of Thoracic Surgery, [2]Çiğli Training and Research Hospital Department of Thoracic Surgery, [3]Dr. Suat Seren Chest Diseases and Thoracic Surgery Training and Research Hospital Department of Radiology, Izmir, Turkey

Address for correspondence:
Dr. Tevfik Ilker Akçam, Department of Thoracic Surgery, Ege University School of Medicine, Izmir, Turkey.
E-mail: tevfikilkerakcam@hotmail.com

Introduction

Preoperative evaluation is very important in thoracic surgery for the determination of the surgical suitability, estimation of the postoperational pulmonary complications, and patient follow-up.[1,2] Due to emergent operative methods and perioperative medical care facilities, surgical mortality and morbidity have decreased; however, as well as the risk group, postoperative pulmonary complications are still significant due to the increased number of patients in the advanced age group.[3]

In the preoperative evaluation, the first objective is to estimate postoperative complications, and the second objective is to reduce complication risks.[4-6] For this purpose, the planned operations can be determined, and undesirable events can be prevented, according to the results of

How to cite this article: Akcam TI, Kaya SO, Akcay O, Samancilar O, Sevinc S, Susam S, *et al*. Prediction of postoperative pulmonary complications in lung cancer surgery: Is proportion of emphysema important?. Eurasian J Pulmonol 2018;20:7-11.

preoperative evaluations. Respiratory function tests, exercise tests, diffusion, and scintigraphic scannings provide important information about the remaining postoperative lung resistance of the patients.[7] Nonetheless, there is neither a definite explanation about the possible complications nor a gold standard method.[8]

Operational difficulty and possible incidence of complications increase, particularly in patients with emphysema and bullous lung pathology.[9] From this perspective, "Goddard Classification – Score" (GdCS) which was developed by Goddard and used for radiological classification of the patients with chronic obstructive pulmonary disease (COPD)-emphysema was used for the evaluation of the patients that undergone lung resection for lung cancer.[10]

Although GdCS is a radiological classification for COPD patients, it is not used for preoperative evaluation by thoracic surgeons. In this study, GdCS is applied for this specific reason to help predict postoperative pulmonary complications before initial lung cancer surgery. The patients were categorized according to GdCS. The purpose of the present study was to investigate whether this scoring method could be an option for preoperative evaluation, particularly against postoperative pulmonary complications. Thus, the relation between the proportion of emphysema and morbidity was investigated, and we tried to develop an estimated risk prediction.

Materials and Methods

One hundred and four were retrospectively evaluated between January 2011 and October 2013. Among 297 patients who had undergone anatomic lung resection due to primary lung carcinoma for the past 2 years. To obtain a homogeneous patient group, all factors that increase the rate of pulmonary complication were excluded except emphysema. Therefore, patients who underwent pneumonectomy, chest wall resection, neoadjuvant treatment, or bronchoplastic– sleeve resections were excluded from the study. To form a homogeneous group, patients who did not meet these criteria were removed from the study. and continued to study with the other 104 patients. Age, gender, drainage time, postoperative pulmonary complications, and smoking duration of the remaining this 104 patients were recorded. Pulmonary function test was performed preoperatively in all patients. Forced expiratory volume in 1 s (FEV_1) values were recorded.

These 104 patients were classified according to GdCS by a blinded radiologist. By this method of evaluation, both of the lungs are divided into three different zones, and each zone is scored individually according to thorax computerized tomography scans. Normal parenchymal tissue is scored as "0" (zero), whereas 75%–100% destroyed parenchymal tissue is scored as 4. The maximum evaluation score is 24.[10,11] Hence, patients with no parenchymal pathology were in Group G0, patients with 0%–25% of parenchyma pathology and lack of vascularity were in Group G1, patients with 25%–50% of parenchyma pathology-lack of vascularity were in Group G2, patients with 50%–75% of parenchyma pathology-lack of vascularity were in Group G3, and patients with 75%–100% parenchyma damage were in Group G4 [Figure 1]. The correlation between GdCS and postoperative pulmonary complications are examined.

The procedures followed were in accordance with the ethical standards of the responsible committee on human experimentation (institutional and national) and with the Helsinki Declaration of 1975, as revised in 2000 and 2008.

Statistical analysis

Statistical analysis was carried out using SPSS version 20.0 software (IBM statistics for Windows version 20, IBM Corporation, Armonk, New York, United States). was used for all statistical analyses. Descriptive statistical variables were presented as the mean ± standard deviation or percentages (%). The Kolmogorov–Smirnov test was used to test the fitness of the distribution of quantitative variables; parametric methods were used to analyze variables that showed normal distribution and equal variance, whereas nonparametric methods were used to analyze variables that showed normal distribution and unequal variance. Correlation between groups was calculated using Spearman test. One-way ANOVA was used for associated samples, whereas the

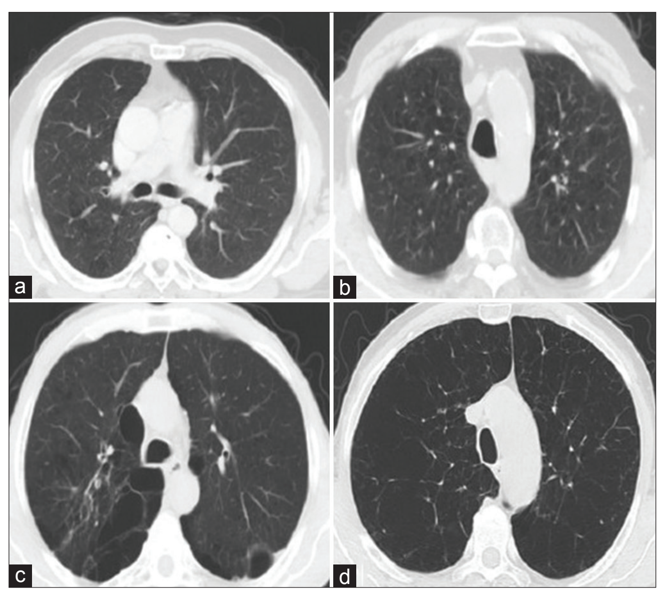

Figure 1: Parenchyma damage degree and loss of vascularity. (a) 0%–25% of parenchyma degeneration-loss of vascularity. (b): 25%–50% degeneration-loss of vascularity. (c): 50%–75% of degeneration-loss of vascularity (d): 75%–100% nearly total parenchyma damage

Mann–Whitney U-test and Chi-squared tests were used for variables that were not normally distributed. Data were analyzed in 95% confidence intervals, and values of $P < 0.05$ were considered statistically significant. All patients gave written informed consent.

Results

There were 100 male and 4 female patients in the study. The mean age of the patients was 61.25 ± 8.49 (40–79) years. Fifty-one (49%) patients were diagnosed with squamous cell carcinoma, 46 (44%) patients with adenocarcinoma, and seven (7%) patients as large cell neuroendocrine tumor. When GdCS scores of these 104 patients were calculated, 10 (9.6%) patients were in Group G0, 28 (26.9%) patients were in Group G1, 42 (40.4%) patients were in Group G2, 22 (21.2%) patients were in Group G3, and 2 (1.9%) patients were in Group G4. The low patient number in Group G4 was attributed to the medical unsuitability for operation.

The mean drainage day was 9.79 ± 7.28/day (3–48). Average drainage increased with increasing GdCS (G0: 5.6 ± 1.72/day [[3–21]; G1: 6.5 ± 0.67/day [3–15]; G2: 10.93 ± 1.24/day [4–48]; G3: 13.64 ± 1.68/day [4–34]; G4: 10.5 ± 3.5/day [7–14]; $P = 0.002$]) [Table 1].

During the postoperative follow-up, pulmonary complications developed in 35 of the 104 patients (33.6%). There was a prolonged air leak in 22 patients (21.1%), atelectasis requiring bronchoscopy in seven patients (6.7%), pneumonia in three patients (2.8%), and empyema in three patients (2.8%). According to the distribution of the patients, the incidence rate of a pulmonary complication was high in the patients with high GdCS ($P < 0.05$) [Table 2].

During the comparison of patients' FEV_1 percentages and GdCS, there was no significant correlation, although FEV_1 values decreased in patients with increased GdCS ($P = 0.182$) [Table 3].

To achieve a general approach, mean FEV_1 percentages of patients with pulmonary complications were analyzed independently from other parameters. While mean FEV_1 was lower in the group with complications, this decrease had no effect on the development of pulmonary complications. This was analyzed by dividing the patients into more specific subgroups. Mean FEV_1 percentages for GdCS groups were calculated, and the potential effect of these percentages on pulmonary complication rates was investigated. The incidence of complications showed a marked increase with decreasing mean FEV_1 percentage, but this was not statistically significant [Table 4].

Smoking status of the patients included in the study was classified under three subgroups. Patients who smoked 20 packages/year were in Group I, patients who smoked 20–50 packages/year were in Group II, and patients who smoked ≥50 packages/year with a smoking history were in Group III. According to these categories, as well as GdCS groups, there was a generally homogeneous distribution, and the smoking rate of category II was higher in Groups G2 and G3 compared to the other groups.

Table 1: The correlation between Goddard Classification Score and drainage duration

GdCS	*n*	Mean (/day)±SD	Minimum (/day)	Maximum (/day)
0	10	5.60±5.46	3	21
1	28	6.50±3.56	3	15
2	42	10.93±8.05	4	48
3	22	13.64±7.89	4	34
4	2	10.50±4.95	7	14
Total	104	9.79±7.28	3	48

P=0.002. GdCS: Goddard Classification Score, *n*: Number of patients, SD: Standard deviation

Table 2: The correlation between Goddard Classification Score and complications

GdCS	Complication		Total (*n*)
	No, *n* (%)	Yes, *n* (%)	
0	8 (80.0)	2 (20.0)	10
1	24 (85.7)	4 (14.3)	28
2	28 (66.7)	14 (33.3)	42
3	8 (36.4)	14 (63.6)	22
4	1 (50.0)	1 (50.0)	2
Total	69	35	104

P<0.05. GdCS: Goddard Classification Score, *n*: Number of patients

Table 3: The correlation between Goddard Classification Score and forced expiratory volume in the 1st s

GdCS	*n*	Mean FEV_1 (%)	Minimum (%)	Maximum (%)
0	10	80.10	67	95
1	28	76.21	46	108
2	42	76.62	45	122
3	22	67.59	34	98
4	2	68.50	51	86
Total	104	74.78	34	122

P=0.182. GdCS: Goddard Classification Score, *n*: Number of patients, FEV_1: Forced expiratory volume in the 1st s

Table 4: The correlation between forced expiratory volume in the 1st s and complications

GdCS	*n*	FEV_1 (%)	Complication	
			No, *n* (%)	Yes, *n* (%)
0	10	80.10	8 (80.0)	2 (20.0)
1	28	76.21	24 (85.7)	4 (14.3)
2	42	76.62	28 (66.7)	14 (33.3)
3	22	67.59	8 (36.4)	14 (63.6)
4	2	68.50	1 (50)	1 (50)
Total	104	74.78	69	35

GdCS: Goddard Classification Score, *n*: Number of patients, FEV_1: Forced expiratory volume in the 1st s

Discussion

Emphysema is defined as the abnormal dilation and comorbid alveolar destruction of the air spaces in the distal terminal bronchiole.[12] Emphysema is an important cause of mortality and morbidity worldwide.[13] Therefore, many studies have been conducted, particularly on the effects and detection of emphysema, and some studies are still ongoing. There is not enough study that is such an important issue for thoracic surgery. Although there is a frightening picture by surgeons, there is no objective data on the patient. In this study, the patient has been expressed with numerical values as possible. It was found that the increase in the degree of emphysema increased the incidence of postoperative complications and extended the duration of the average drainage day. Although it was not statistically significant, the increase in the level of emphysema, the FEV_1 value decreased together. It is possible to calculate these values because of the possibility of CT in today's technology. Computed tomography (CT) has been shown to be the most effective means to detect emphysema; lung parenchyma affected by emphysema is observed as low-density areas in CT, and the number and caliber of parenchymal vessels decrease.[14] Chest X-ray can provide limited information to reveal emphysema.[15] CT constitutes the core of the evaluation, which shows the presence, penetration, and distribution of emphysema. It is easier to detect emphysema, particularly by using high-resolution CT.[16] The minimum intensity projection method can be used to evaluate 1 mm sections and mild emphysema. This method clarifies the lowest density areas of the lung while making the remaining normal parenchyma and veins less visible. To detect latent emphysema, this method has been shown to be more sensitive compared to HRCT.[17]

There are two methods to determine emphysema, namely, the observer-based semi-quantitative method[10,18] and the quantitative method through software. When pathological results were compared, they were found to be correlated in both ways.[19] In a study to determine the automation awareness, two different methods were compared to investigate the expected benefit in patients who underwent lung volume reduction surgery. In conclusion, studies have shown that evaluation using automated systems does not contribute significantly to the evaluations by semi-quantitative scoring methods that are performed by experienced observers.[20]

The most common semi-quantitative method is Goddard's method.[10] Studies have shown that this evaluation can be performed by radiologists or lung experts.[21] In another study that used GdCS as the reference, Asai *et al*.[22] investigated the degree of emphysema and pneumothorax development in cases that underwent needle biopsy, and the authors stated that structural lung deformities did not contribute to pneumothorax development. On the other hand, the current study revealed that high GdCS, i.e., increased parenchyma degeneration – contributed to the development of complications. In a similar work, Sevinc *et al*.[11] have shown that the degree of emphysema and therefore, GdCS are linked to a prolonged air leak and pneumothorax episodes. In this context, it was found that complications were more common in those with high GdCS in our study.

Limitations of subjective visual evaluation, CT characteristics of emphysema morphology, and digital features of CT data increase the interest in an objective, quantitative evaluation methods that can be performed by using the various automated software.[23] The most frequent quantitative evaluation method is densitometric analysis. One of the parameters used in this analysis is relatively low-density area. It is defined as the ratio of emphysematous parenchymal areas with a density lower than a predefined threshold value (determined from previous studies).[14,19] Earlier studies have shown that the presence of a low parenchymal density area is parallel to pulmonary function test results and pathology results.[19,24] Although GdCS was set as the reference in the present study, mean FEV_1 was evaluated. The increase in emphysema caused a prominent decrease in FEV_1, but this was not statistically significant. The authors of the current study reached the conclusion that significance could be achieved by using a larger patient population. Some of the studies that support this notion have stated that FEV_1 alone cannot be effective in determining postoperative complications, and it should be combined with exercise tests.[25] In this study, the incidence of pulmonary complications showed a marked increase with decreasing mean FEV_1 percentage, but this was not statistically significant also. Overall, the authors concluded that the GdCS value could be more sensitive to indicate the rate of complications, compared to mean FEV_1 percentage.

Conclusion

General postoperative complications in chest surgery were evaluated in the present study. The observed complication rate of 33.6% was similar compared to the literature.[26] In conclusion, considering the findings of this study within the indicated complication rates, the authors found that the Goddard scoring system, which was developed for COPD-emphysema patients, could be used as a guiding parameter for preoperative evaluation of thoracic surgery patients, and their postoperative follow-up. Measurement of the degree of emphysema by a nonquantitative measurement method may cause distress in the exact determination of the data. In addition, there are additional factors that may cause complications in the thoracic surgery patients. However, the isolated effect of the degree of emphysema has been mentioned in this study. The authors believe that the use of GdCS in existing preoperative evaluation parameters, provided that it is supported by other clinical studies, will provide a new preoperative parameter.

Financial support and sponsorship
Nil.

Conflicts of interest
There are no conflicts of interest.

References

1. Colice GL, Shafazand S, Griffin JP, Keenan R, Bolliger CT; American College of Chest Physicians. Physiologic evaluation of the patient with lung cancer being considered for resectional surgery: ACCP evidenced-based clinical practice guidelines (2nd edition). Chest 2007;132:161S-77S.
2. van Tilburg PM, Stam H, Hoogsteden HC, van Klaveren RJ. Pre-operative pulmonary evaluation of lung cancer patients: A review of the literature. Eur Respir J 2009;33:1206-15.
3. Ludwig C, Stoelben E, Olschewski M, Hasse J. Comparison of morbidity, 30-day mortality, and long-term survival after pneumonectomy and sleeve lobectomy for non-small cell lung carcinoma. Ann Thorac Surg 2005;79:968-73.
4. British Thoracic Society, Society of Cardiothoracic Surgeons of Great Britain and Ireland Working Party. BTS guidelines: Guidelines on the selection of patients with lung cancer for surgery. Thorax 2001;56:89-108.
5. Datta D, Lahiri B. Preoperative evaluation of patients undergoing lung resection surgery. Chest 2003;123:2096-103.
6. Brunelli A, Refai M, Xiumé F, Salati M, Sciarra V, Socci L, *et al.* Performance at symptom-limited stair-climbing test is associated with increased cardiopulmonary complications, mortality, and costs after major lung resection. Ann Thorac Surg 2008;86:240-7.
7. Charloux A, Brunelli A, Bolliger CT, Rocco G, Sculier JP, Varela G, *et al.* Lung function evaluation before surgery in lung cancer patients: How are recent advances put into practice? A survey among members of the European Society of Thoracic Surgeons (ESTS) and of the Thoracic Oncology Section of the European Respiratory Society (ERS). Interact Cardiovasc Thorac Surg 2009;9:925-31.
8. Brunelli A, Charloux A, Bolliger CT, Rocco G, Sculier JP, Varela G, *et al.* The European Respiratory Society and European Society of Thoracic Surgeons clinical guidelines for evaluating fitness for radical treatment (surgery and chemoradiotherapy) in patients with lung cancer. Eur J Cardiothorac Surg 2009;36:181-4.
9. Bobbio A, Chetta A, Carbognani P, Internullo E, Verduri A, Sansebastiano G, *et al.* Changes in pulmonary function test and cardio-pulmonary exercise capacity in COPD patients after lobar pulmonary resection. Eur J Cardiothorac Surg 2005;28:754-8.
10. Goddard PR, Nicholson EM, Laszlo G, Watt I. Computed tomography in pulmonary emphysema. Clin Radiol 1982;33:379-87.
11. Sevinc S, Kaya SO, Akcam TI, Ceylan KC, Ozturk O, Susam S, *et al.* Prolonged air leakage in secondary spontaneous pneumothorax: Is proportion of emphysema important? Clin Respir J 2017;11:833-8.
12. The definition of emphysema. Report of a National Heart, Lung, and Blood Institute, Division of Lung Diseases Workshop. Am Rev Respir Dis 1985;132:182-5.
13. Lindberg A, Jonsson AC, Rönmark E, Lundgren R, Larsson LG, Lundbäck B, *et al.* Prevalence of chronic obstructive pulmonary disease according to BTS, ERS, GOLD and ATS criteria in relation to doctor's diagnosis, symptoms, age, gender, and smoking habits. Respiration 2005;72:471-9.
14. Webb WR, Stein MG, Finkbeiner WE, Im JG, Lynch D, Gamsu G, *et al.* Normal and diseased isolated lungs: High-resolution CT. Radiology 1988;166:81-7.
15. Müller NL, Coxson H. Chronic obstructive pulmonary disease 4: Imaging the lungs in patients with chronic obstructive pulmonary disease. Thorax 2002;57:982-5.
16. Madani A, Zanen J, de Maertelaer V, Gevenois PA. Pulmonary emphysema: Objective quantification at multi-detector row CT – Comparison with macroscopic and microscopic morphometry. Radiology 2006;238:1036-43.
17. Remy-Jardin M, Remy J, Gosselin B, Copin MC, Wurtz A, Duhamel A, *et al.* Sliding thin slab, minimum intensity projection technique in the diagnosis of emphysema: Histopathologic-CT correlation. Radiology 1996;200:665-71.
18. Bankier AA, De Maertelaer V, Keyzer C, Gevenois PA. Pulmonary emphysema: Subjective visual grading versus objective quantification with macroscopic morphometry and thin-section CT densitometry. Radiology 1999;211:851-8.
19. Gevenois PA, de Maertelaer V, De Vuyst P, Zanen J, Yernault JC. Comparison of computed density and macroscopic morphometry in pulmonary emphysema. Am J Respir Crit Care Med 1995;152:653-7.
20. Washko GR, Hoffman E, Reilly JJ. Radiographic evaluation of the potential lung volume reduction surgery candidate. Proc Am Thorac Soc 2008;5:421-6.
21. Hersh CP, Washko GR, Jacobson FL, Gill R, Estepar RS, Reilly JJ, *et al.* Interobserver variability in the determination of upper lobe-predominant emphysema. Chest 2007;131:424-31.
22. Asai N, Kawamura Y, Yamazaki I, Sogawa K, Ohkuni Y, O'uchi T, *et al.* Is emphysema a risk factor for pneumothorax in CT-guided lung biopsy? Springerplus 2013;2:196.
23. Gevenois PA, Yernault JC. Can computed tomography quantify pulmonary emphysema? Eur Respir J 1995;8:843-8.
24. Gevenois PA, De Vuyst P, de Maertelaer V, Zanen J, Jacobovitz D, Cosio MG, *et al.* Comparison of computed density and microscopic morphometry in pulmonary emphysema. Am J Respir Crit Care Med 1996;154:187-92.
25. Pate P, Tenholder MF, Griffin JP, Eastridge CE, Weiman DS. Preoperative assessment of the high-risk patient for lung resection. Ann Thorac Surg 1996;61:1494-500.
26. Wang J, Olak J, Ultmann RE, Ferguson MK. Assessment of pulmonary complications after lung resection. Ann Thorac Surg 1999;67:1444-7.