Factors Determining the Severity of Pulmonary Function Impairment in Silicotic Patients

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Objective: *Silicosis is the most common occupational lung disease in Thailand. Determinants of pulmonary function impairment in Thai silicotic patients have not been mentioned before.*
Material and Method: *The present study was conducted in silicotic patients who attended the Siriraj Occupational Lung Clinic in the year 2006. Patients were classified according to the forced expiratory volume in one second (FEV1) into the severe impairment group (< 50% predicted) and the non-severe group (FEV1 ≥ 50% predicted) which includes normal FEV1. Comparison between the two groups in terms of demographic characteristics, smoking history, history of pulmonary tuberculosis, and radiographic features were assessed.*
Results: *Thirty-four patients of which 24 were female (70.6 %) had an overall mean age of 53.7 years. Seven patients (20.6%) had severe impairment, four were female, three were smokers, and two had a history of pulmonary tuberculosis. All of the severe impairment patients had nodule profusion in category 2 and had large opacity. Only the presence of large opacity was significantly associated with the severity of pulmonary function impairment (p = 0.002).*
Conclusion: *Only the presence of large opacity in a chest radiograph can determine the severity of pulmonary function impairment in Thai silicotic patients.*

Keywords: *Silicosis, Chest radiograph, Pulmonary function*

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Silicosis is an occupational lung disease secondary to exposure to free crystalline silica. It is the most common and the most dangerous occupational lung disease in Thailand[1]. Exposure to silica in the workplace that appears not to disturb roentgenographic picture can still cause chronic airflow limitation and/or mucus hypersecretion and/or pathologic emphysema. In patients with obvious disease, spirometry usually reflects a mixed pattern of irreversible airflow obstruction and restriction[2]. There is a consistent association between an increase of pulmonary function abnormalities and cumulative silica exposure even within the current allowable regulatory level[3]. Among gold miners in Canada, patients with silicosis suffered a substantial loss of pulmonary function that was directly in proportion with the nodule profusion on their initial chest radiographs[4]. Recent report from Hong Kong revealed that age, cigarette pack-years, history of tuberculosis, nodule size, nodule profusion, and progressive massive fibrosis were independent predictors of spirometric abnormalities.

The present study aimed to assess the influencing factors for the severity of pulmonary function impairment in Thai silicotic patients.

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Material and Method

A cross-sectional study was conducted in silicotic patients who had a regular follow-up visit at Siriraj Occupational Lung Clinic in the year 2006. The diagnosis of silicosis was made by standardized criteria of the Thoracic Society of Thailand. Demographic data including age, sex, smoking status, type and duration of work, and history of pulmonary tuberculosis, were collected.

Each chest radiograph was interpreted by the authors independently using the 2000 International Labor Organization system[6]. The results were recorded in a standardized format and the most concordant interpretation or value in between was selected as a final result. Radiographic features were categorized into nodule profusion (1, 2, or 3), round or irregular opacity, and presence or absence of large opacity.

Spirometry was performed in a standardize manner[7] using Vitalograph-Compaq II (Vitalograph Co., Buckingham, UK). The results include forced expiratory volume in one second (FEV1), forced vital capacity (FVC), and % FEV1/FVC that were compared to the reference value of adult Thais[8]. Obstructive ventilatory defect was defined as FEV1/FVC < 90% predicted and restrictive ventilatory defect was defined as FVC < 80% predicted associated with FEV1/FVC ≥ 90% predicted[9]. When FEV1/FVC < 90% predicted and FVC < 80% predicted, it was interpreted as combined obstructive and restrictive ventilatory defects. Patients were categorized into the severe impairment group if their FEV1 was less than 50% predicted regardless of the pattern of abnormalities[10], and the rest were placed in the non-severe impairment group which also included those with normal spirometry (FEV1/FVC ≥ 90% predicted associated with FVC ≥ 80% predicted).

Statistic analysis

SPSS software version 13.0 for window (SPSS Inc., Chicago, USA) was used for all statistical analyses. Contingency table methods were used to assess relationships between the impairment and categorical variables by Fisher's exact test. A p-value of < 0.05 was taken to be statistically significant.

Results

Thirty-four silicotic patients were included. All of them were either stone crushers or ceramic workers with a duration of work of more than 15 years. Twenty (58.8%) of them have continued their work since the diagnosis. The mean age was 53.7 years (range 43-72), 24 were female (70.6%). History of tuberculosis was present in 5 patients (14.7%), and 13 of them (38.2%) had a significant smoking history. Their radiographic characteristics are shown in Table1.

Seven of 34 patients (20.6%) had normal spirometry, 13 patients (38.2%) had an obstructive ventilatory defect, four patients (11.8%) had a restrictive ventilatory defect, and 10 patients (29.4%) had both obstructive and restrictive ventilatory defects. The detail spirometric results are shown in Table 2.

All seven patients categorized into the severe impairment group had an obstructive ventilatory defect, two had a history of tuberculosis, and three had significant smoking history. Nodule profusion of category 2 and large opacity were present in all severe impairment patients, but only two of them had round-shaped opacity. Only the presence of large opacity was significantly associated with the severity of pulmonary function impairment (p = 0.002), while sex,

Table 1. Clinical and radiological characteristic of silicotic patients

		Number (%)		p-value
		Severe (n = 7)	Non-severe (n = 27)	
Sex	Male	3 (42.9)	7 (25.9)	0.394
	Female	4 (57.1)	20 (74.1)	
Tuberculosis	Ever	2 (28.6)	3 (11.1)	0.268
	Never	5 (71.4)	24 (88.9)	
Smoking history	Yes	3 (42.9)	10 (37)	1.000
	No	4 (57.1)	17 (73)	
Nodule profusion	Category 1	0 (0)	3 (11.1)	0.183
	Category 2	7 (100)	16 (59.3)	
	Category 3	0 (0)	8 (29.6)	
Nodule shape	Round	2 (28.6)	20 (25.9)	0.070
	Irregular	5 (71.4)	7 (74.1)	
Large opacity	Presence	7	9	0.002
	Absence	0	18	

Table 2. Pattern of pulmonary function

Results	No. (%)	Mean FEV1 (%predicted)	Mean FVC (%predicted)	Mean FEV1/FVC (%predicted)
Normal	7 (20.6)	92.3	93.9	96.9
Obstruction	13 (38.2)	69.7	92.5	71.6
Restriction	4 (11.8)	68.2	71.1	95.4
Mixed obstruction and restriction	10 (29.4)	49.7	70.3	69.0

smoking history, history of tuberculosis, nodule profusion, and nodule shape were not (Table 1).

Discussion

The pattern of radiographic findings and pulmonary function results of silicotic patients in Thailand has never been described before. Although more than two-third of the present study population were female, sex is not a determinant for severity of pulmonary function impairment. The study of ceramic workers in Italy showed that no gender preponderance for acquiring silicosis[11], but another study from Sweden found a more pronounced progression of silicosis among women when compared with men[12]. It has long been recognized that silicosis enhances the development of tuberculosis, but the prevalence of tuberculosis (14.7 %) in the present study was lower than those reported from South Africa (22.3 %) and Hong Kong (36.9 %)[4,5]. In both studies, a history of tuberculosis influenced the pulmonary function abnormalities, but the authors found that it could not predict the severity of impairment in silicotic patients from Thailand.

Classically, silicosis, as well as asbestosis, are the two most common pneumoconioses that have the potential to cause restrictive ventilatory defect from lung tissue reaction. In addition, silicotic nodules also occur in close proximity to small and medium airways resulting in luminal distortion. The hypertrophy and scarring bronchial-associated lymphoid tissue and intrapulmonary lymph node may compress larger airways[13]. These combining effects can lead to mainly obstructive (38.2%) or mixed obstructive and restrictive ventilatory (29.4%) defects as demonstrated in the present study. The contribution of airway obstruction in silicotic patients from Thailand is higher than reported from South Africa[14], Canada[15], United States[16], and Hong Kong[5], although the smoking history was less. This may result from different working environments and dust composition rather than the effect of tobacco smoke.

Tobacco smoking is a great confounder for many occupational lung diseases especially for silicosis. In contrast to previous studies[3,5,15,16], although the effect of smoking on pulmonary function decline is obvious, a history of smoking in silicosis patients from Thailand did not determine the severity of pulmonary function impairment.

Nodule profusion usually reflects the extent of parenchymal abnormality indicated from a chest radiograph. All of the severe impairment patients in the present study had nodule profusion of category 2, and nearly one-third of the non-severe group had the most pronounced nodule profusion of category 3. Conflicting evidences have been demonstrated in the correlation between nodule profusion and pulmonary function abnormalities[4,5,16,17]. With the advent of computerized tomography (CT), the poor correlation between pulmonary function abnormalities and nodule profusion was demonstrated to be the common phenomenon[18,19]. Air trapping and emphysema, markers of airflow obstruction, were also clearly evident from CT scan of silicotic patients[15,19,20].

In patients with more advanced silicosis, nodular lesions conglomerate into larger opacities or progressive massive fibrosis, resulting in severe architecture distortion and permanent disability to the patients[13]. The presence of large opacity in all subjects from the severe impairment group of the present study is shown to be the only factor determining this catastrophic event for the patients. A study from Hong Kong using plain chest radiograph also revealed that progressive massive fibrosis was an independent predictor of airflow obstruction[5]. The CT scan appearances have also confirmed the presence of paracicatricial emphysema in those with confluent silicosis and may explain the worsening of airflow obstruction and pulmonary function impairment[15].

Conclusion

Presence of large opacity in chest radiograph

is the only factor determining the severity of pulmonary function impairment in Thai silicotic patients.

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ปัจจัยที่มีผลต่อความรุนแรงของการสูญเสียสมรรถภาพปอดในผู้ป่วยโรคซิลิโคสิส

นิธิพัฒน์ เจียรกุล, ติราภรณ์ บุณยรัตพันธุ์, อรรถ นานา

วัตถุประสงค์: *ซิลิโคสิสเป็นโรคปอดจากการทำงานที่พบได้บ่อยในประเทศไทย ยังไม่เคยมีการศึกษาถึงปัจจัยที่มีผลต่อการสูญเสียสมรรถภาพปอดในผู้ป่วยกลุ่มนี้มาก่อน*

วัสดุและวิธีการ: *ทำการศึกษาในผู้ป่วยโรคซิลิโคสิสจากการทำงานที่มาทำการตรวจรักษาในคลินิกโรคปอด โรงพยาบาลศิริราช ในปีพ.ศ. 2549 โดยแบ่งผู้ป่วยตามค่า forced expiratory volume in one second (FEV1) เป็น 2 กลุ่ม คือ กลุ่มสูญเสียรุนแรง (ค่า FEV1 น้อยกว่าร้อยละ 50 ของค่ามาตรฐาน) และ กลุ่มสูญเสีย ไม่รุนแรง และไม่สูญเสีย (ค่า FEV1 มากกว่าหรือเท่ากับร้อยละ 50 ของค่ามาตรฐาน) แล้วทำการเปรียบเทียบระหว่าง 2 กลุ่มในด้านปัจจัยพื้นฐาน ประวัติการสูบบุหรี่ ประวัติวัณโรค และ ลักษณะทางภาพถ่ายรังสีทรวงอก*

ผลการศึกษา: *มีผู้ป่วยทั้งหมด 34 ราย เป็นหญิง 24 ราย (ร้อยละ 70.6) โดยมีอายุเฉลี่ย 53.7 ปี ผู้ป่วย 7 รายจัดอยู่ในกลุ่มสูญเสียรุนแรง (ร้อยละ 20.6) โดยเป็นชาย 4 ราย หญิง 3 ราย ในกลุ่มสูญเสียรุนแรงนี้ 3 รายมีประวัติสูบบุหรี่ 2 รายเคยเป็นวัณโรคปอด ทั้งหมดทุกรายมีการกระจายตัวของจุดในภาพถ่ายรังสีทรวงอกอยู่ในระดับ 2 และพบลักษณะรวมเป็นก้อนขนาดใหญ่ จากการวิเคราะห์ตัวแปรพบว่าเฉพาะการพบก้อนขนาดใหญ่เท่านั้นที่มีผลต่อความรุนแรงของการสูญเสียสมรรถภาพปอด (p = 0.002)*

สรุป: *การพบก้อนขนาดใหญ่จากภาพถ่ายรังสีทรวงอก เป็นปัจจัยอันเดียวที่มีส่วนกำหนดความรุนแรงของการสูญเสียสมรรถภาพปอดในผู้ป่วยโรคซิลิโคสิสในประเทศไทย*