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Coal workers' pneumoconiosis and surveillance: A 5-year experience

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Abstract:

BACKGROUND: Coal workers' pneumoconiosis (cwp) is a parenchymal lung disease caused by inhalation of dust from coal and rocks in the mine. It is possible to prevent the disease completely with effective dust control; however, the secondary protection measures (screening and surveillance programs) are recommended in cases where effective dust control cannot be achieved.

AIMS AND OBJECTIVES: The aim of this study is to discuss the cwp surveillance program and the duties and powers of the workplace physicians in turkey based on the assessment results of cases referred to our clinic by workplace physicians due to suspicion of cwp.

MATERIALS AND METHODS: This is a cross sectional study. The archive data were evaluated by occupational diseases specialists.

RESULTS: Of the 127 coal mine workers, all males with a mean age of 40.5 ± 8.9 Years, 63 (49.6%) Were diagnosed as cwp. The duration of exposure to coal dust ranged from 7 to 390 months, and the mean duration of exposure was 129.1 ± 82.2 Months. Of the 127 coal mine workers, 49.6% Were diagnosed as cwp.

CONCLUSION: According to the findings obtained in the present study, the assessment made by the workplace physician and radiological evaluation plays a key role in the diagnosis and followup of cwp. In turkey, periodic examinations continue to be the most important component of secondary protection in terms of occupational risk. Pulmonary radiography is used as an indispensable component of early diagnosis in employees at risk of developing pneumoconiosis. Furthermore, screening programs should be evaluated with risk assessment and exposure information. Workplace physicians should reevaluate the periodic examination and ilo assessment services in terms of technical and reader quality.

Keywords:

Coal workers' pneumoconiosis, dust exposure, occupational diseases, primary prevention

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Introduction

Coal workers' pneumoconiosis (CWP) is a parenchymal lung disease caused by inhalation of dust from coal and rocks in the mine. The radiological appearance of simple CWP is typically parenchymal small-rounded (1–5 mm) opacities. On the other hand, in complicated CWP, deterioration in parenchymal structure and large opacities may be seen besides small opacities. Important radiological findings of CWP include the presence of emphysema, bullae, and air-trapping sites.[1]

The main determinant of the risk of CWP development is the exposure time to coal dust and the intensity of exposure. An increase in both determinants increases the risk of developing CWP. Exposed coal dust causes cell destruction through reactive oxygen and nitrogen radicals.[2] Other

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important parameters are known to be carbon, silica, and iron content of coal dust and personal factors (e.g., smoking, additional diseases, etc.).[3,4]

CWP is still one of the most common pneumoconioses in the world. In the guideline published by the International Labor Organization (ILO) in 2013, the prevalence of CWP was reported to be 18.8%.[5] Although CWP incidence has been reported to decrease gradually in developed countries, it continues to be one of the most important occupational diseases for developing countries. In a research evaluating the data of national occupational diseases in China, 60.8% of 23.152 new occupational disease cases have been reported as CWP.[6] It was estimated that between 25.000 deaths were caused by CWP globally in 2013.[7] Occupational disease statistics are published by the Social Security Institution (SSI) in Turkey. According to the SSI's statistical yearbook, 18 (2.6%) of 691 employees diagnosed with the occupational disease in 2017 were reported as CWP.[8] This number refers only to cases that have been found to have permanent loss of the earning capacity in the profession and indicates the presence of functional loss as well as severe parenchymal findings. It is possible to prevent the disease completely with effective dust control; however, the secondary protection measures are recommended in cases where effective dust control cannot be achieved. The most important of these measures is screening and surveillance programs.[7,9] In Turkey, examinations and evaluations are performed within the scope of periodic surveillance programs performed in the workplaces for the diagnosis and follow-up of pneumoconiosis with the regulations made as per the Occupational Health and Safety Law no. 6331.[10] The examinations to be requested within the scope of the periodic follow-up are at the discretion of the workplace physician and are mostly carried out through ILO posteroanterior (PA) chest X-ray assessment and pulmonary function test (PFT). Workplace physicians are responsible for finalizing the diagnosis by referring cases considered suspicious as a result of the ILO assessment to authorized hospitals.[11]

The aim of this study is to discuss the CWP surveillance program and the duties and powers of the workplace physicians in Turkey based on the assessment results of cases referred to our clinic by workplace physicians due to suspicion of CWP.

Materials and Methods

Selection of cases and assessment of occupational disease

Following the exclusion of repeated applications, it was seen that 40.8% (n = 712) of the patients admitted to our outpatient clinic between September 2013 and December 2018 were referred with a preliminary diagnosis of pneumoconiosis. Of these cases, 17.8% (n = 127) were coal workers. All cases were included in the study without any sample selection. The diagnosis of pneumoconiosis was made with the exclusion of work history, radiological findings, and other possible diagnoses.[12]

Referral information, complaints, history (operation, accident, sportive activity, allergic disease, and chronic disease history), hobbies, habits (smoking etc.), family history, employment history (all the jobs including additional works and military service since the apprenticeship period, occupational training, dust type, amount, density, and duration of exposure to dust, and other workplace risks), environmental history (asbestos exposure, bird feeding history, etc.), physical examination and laboratory findings (PFT, chest X-ray, and lung computed tomography [CT], if available) were evaluated. Chest X-rays were evaluated according to the ILO standard.[13]

Statistical analysis

Descriptive findings were expressed as percent, mean ± standard deviation, or median (minimum value-maximum value). Kolmogorov–Smirnov test and Kurtosis and Skewness coefficients were used to determine whether variables were distributed normally. In paired analyses, t-test, Mann–Whitney U test, and Chi-square test were used. $P < 0.05$ was considered statistically significant. Statistical analysis was performed using SPSS version 21.0 software (SPSS Inc. Version 21.0, Chicago, USA).

Results

Of the 127 coal mine workers, all males with a mean age of 40.5 ± 8.9 years, who were referred to our clinic with the preliminary diagnosis of CWP, 63 (49.6%) were diagnosed as CWP. The duration of exposure to coal dust ranged from 7 to 390 months, and the mean duration of exposure was 129.1 ± 82.2 months. Of the cases, 46.4% stated that there was an effective ventilation system in their workplace and 45.7% stated that they used masks regularly. While 52% of the cases were smokers, 20.4% had quit smoking, and the median cumulative exposure to tobacco smoke was calculated as 13 (1–80) pack-years. There was no significant difference between the cases with and without pneumoconiosis in terms of age, smoking, and pack-year ($P > 0.05$). The duration of exposure to dust was significantly higher in patients with pneumoconiosis than those without pneumoconiosis ($P < 0.05$). Of the cases diagnosed with pneumoconiosis, 34.9% stated that there was an effective ventilation system in their workplace, whereas this rate was 57.8% in cases without pneumoconiosis ($P < 0.05$). Although the use of masks

regularly was lower in patients with pneumoconiosis than those without pneumoconiosis, the difference between the cases was not significant. The presence of complaints and physical examination findings were higher in patients diagnosed with CWP; however, there was no significant difference between the groups in this regard ($P > 0.05$). There were no white-collar workers among the cases diagnosed with pneumoconiosis; however, 7.8% ($n = 5$) of the patients who were not diagnosed with pneumoconiosis were white-collar workers. Table 1 presents the data of the cases referred with a preliminary diagnosis of CWP.

Periodic ILO chest radiograph readings of 65.4% ($n = 83$) of the patients referred with a diagnosis of CWP were obtained from their workplace physicians. It was seen that 37.3% ($n = 31$) of the radiograph readings were evaluated as Quality 2. In 90.4% of the cases, the dominant opacity was determined as P in ILO reading. Table 2 shows the distribution of profusion and opacity of the chest X-rays of these cases.

Table 1: Characteristics of coal mine workers with and without coal workers' pneumoconiosis

	Mean±SD		*P*
	With CWP (*n*=63)	Without CWP (*n*=64)	
Age	41.2±9.1	39.8±8.7	0.359
Duration of exposure (month)	148.9±80.2	109.6±80.1	0.007
Smoking status, *n* (%)			
Smoker	37 (58.7)	29 (45.3)	0.318*
Never-smoker	15 (23.8)	20 (31.3)	
Ex-smoker	11 (17.5)	15 (23.4)	
Presence of effective ventilation system in the workplace	22 (34.9)	37 (57.8)	0.010
Presence of any symptoms	22 (34.9)	15 (23.4)	0.154
Presence of physical examination findings	20 (37.1)	12 (18.8)	0.092
Referring doctor			
SSI	9 (14.3)	9 (14.1)	0.656*
Chest disease specialists	17 (27)	13 (20.3)	
Workplace physician	37 (58.7)	42 (65.6)	

*For all *P*>0.05. CWP: Coal workers' pneumoconiosis, SD: Standard deviation, SSI: Social Security Institution

Table 2: Evaluation of periodic International Labor Organization chest radiograph readings obtained from workplace physicians (*n*=83)

Group	Subgroup	*n* (%)
Dominant opacity	p opacity	75 (90.4)
	q opacity	3 (3.6)
	s opacity	5 (6.0)
	Large opacity (A, B, C)	-
	ax	-
Profusion	Category 0	15 (18.1)
	Category 1	64 (77.1)
	Category 2	3 (3.6)
	Category 3	1 (1.2)

Of the 63 patients diagnosed with CWP in our outpatient clinic, 12.7% had normal chest X-ray results, and the diagnosis was made based on the findings on chest CT and employment history. P opacity was dominant in 58.7% of the cases, and 61.1% of the cases were classified as Category 1 as a result of the profusion evaluation. Of the cases, 12.7% were considered to be complicated pneumoconiosis [Table 3].

Forced expiratory volume in 1 s (FEV1), forced vital capacity (FVC), FEV1%, and FVC% values of patients with pneumoconiosis were lower than those without pneumoconiosis; however, the difference between the groups was not statistically significant ($P > 0.05$) [Table 4].

Discussion

According to the findings obtained in the present study, the assessment made by the workplace physician and radiological evaluation plays a key role in the diagnosis and follow-up of CWP. Workplace physicians, as in other occupational diseases, have first-degree responsibility in identifying the cases at risk of pneumoconiosis due to exposure to coal dust, planning a surveillance program for cases with CWP, and the suspicion of CWP by evaluating the findings obtained during follow-up. In Turkey, periodic examinations continue to be the most important component of secondary protection in terms of occupational risk. Pulmonary radiography is used as an indispensable component of early diagnosis in employees at risk of developing pneumoconiosis.

Table 3: Evaluation of chest X-ray according to the International Labor Organization classification in coal workers' pneumoconiosis patients in our clinic (*n*=83)

Group	Subgroup	*n* (%)
Dominant opacity	p opacity	37 (58.7)
	q opacity	17 (27.0)
	s opacity	1 (1.6)
	Large opacity (A, B, C)	2 (3.2)
	ax	6 (9.5)
	hi	6 (9.5)
Profusion category	Category 0	8 (12.7)
	Category 1	41 (65.1)
	Category 2	12 (19.0)
	Category 3	2 (3.2)

Table 4: Results of pulmonary function tests in those with and without coal workers' pneumoconiosis

	Mean±SD		*P*
	With CWP (*n*=63)	Without CWP (*n*=64)	
FEV_1 (L)	3.3±0.8	3.4±0.9	0.470
FEV_1%*	87.9±14.7	89.3±16.2	0.633
FVC (L)	4.2±0.8	4.3±0.9	0.339
FVC%*	90.6±12.3	92.9±15.1	0.347
FEV_1/FVC*	79.3±8.9	78.6±7.4	0.656

*$P < 0.05$. CWP: Coal workers' pneumoconiosis, SD: Standard deviation, FEV_1: Forced expiratory volume in 1 s, FVC: Forced vital capacity

Of our cases, 62.2% were referred to our clinic by their workplace physician due to suspicious findings on their chest X-ray results obtained through the periodic examination. It is compulsory in Turkey to evaluate the chest X-ray results obtained in the workplace according to the ILO standard. This obligation is due to the necessity to standardize the findings and the legal requirements of the social security system.[11] Early diagnosis of pneumoconiosis is possible using the findings obtained through periodic X-ray examinations starting from the date of employment. In our study, it was seen that 58.7% of the employees diagnosed with CWP were referred by workplace physicians. However, 65.6% of the cases referred to our clinic due to CWP suspicion but not diagnosed with CWP were referred by workplace physicians with a preliminary diagnosis of CWP. Periodic radiological evaluations are considered as an important early diagnosis tool. Nevertheless, pneumoconiosis control process leads to unnecessary case evaluation and causes the employee to face risks such as stigmatization and dismissal, resulting in inevitable economic loss, if information about the working environment is not taken into consideration. It is important that the referral information does not include risk assessment results, employment history, and exposure-related information, and it shows that the workplace physician has limitations in the case evaluation process.

As a result of our evaluations, large opacities associated with advanced pneumoconiosis were detected in 12% of the cases. When these cases were evaluated in terms of working duration, the minimum working duration was 48 months and the maximum working duration was 276 months. In other words, considering that these cases were subject to a periodic examination every 6 months and evaluated at least once before the start of their employment, it can be calculated that they had undergone periodic examination at least nine times. Despite the regular X-rays performed in periodic examinations, the presence of these cases may be related to various reasons. Technical inadequacy of radiograms obtained, the reader's competence, or the failure to take into account the radiogram findings can be considered as the reasons why early diagnosis cannot be made. In the early diagnosis of pneumoconiosis of the worker at risk of exposure to dust, evaluation of periodical radiograms and problems in the referral process, which can be resolved by the workplace physician, are seen to be important. However, the identified possible sources of problems are correctable. Correcting the problematic points mentioned above through periodic examinations and ILO readings will further decrease the possibility of delay in early diagnosis.

The role of PA graphy in the early diagnosis of pneumoconiosis is indisputable. However, false-negative results are known to occur particularly in early pneumoconiosis cases (ILO grade: 0/1, 1/1). In a study by Savranlar *et al*.,[13] opacities were found in favor of pneumoconiosis in thorax high-resolution CT (HRCT) results of six of ten patients whose chest X-ray was evaluated as normal. Ren *et al*.[14] reported that there were small opacities compatible with pneumoconiosis in the thoracic HRCT evaluation of coal workers who had no change in their chest radiography. Similarly, Gevenois *et al*.[15] also suggested thoracic HRCT evaluation in case of suspicion in cases in the early period. In the present study, chest X-ray was normal in 12.7% of CWP cases, and the diagnosis was made based on the findings on the chest tomography and employment history. Therefore, evaluation with thoracic HRCT should be considered in terms of early diagnosis in cases who were exposed to dust more in the past. A screening program with low-dose HRCT is being carried out for workers exposed to asbestos in Finland; however, HRCT is not used in any of the screening programs during CWP surveillance.[16] Cost, accessibility, and increased radiation exposure appear as the problems.[7]

In the literature, it has been reported that CWP develops after an average of 10 years of exposure, and the cases are diagnosed over 50 years of age. The mean exposure time to coal dust in the present study was compatible with the literature, but the age of diagnosis was younger than the literature. This result was thought to be related to several possibilities. The two most important factors in the development of pneumoconiosis are intensity and duration of dust exposure.[3,4,16] Based on our results, our cases who were diagnosed with CWP at an earlier age compared to the literature made us think that they were exposed to more intense dust than the cases reported in the literature. However, we do not have workplace dust measurement results. It has been further reported that different rock type and content (silica density, etc.) may be important in the course of pneumoconiosis. The rock content in Turkey may cause the disease to be developed at an earlier age in our cases. However, our sample size is insufficient to discuss this possibility. There is a need for further studies (at the national level if possible) evaluating more extensive data on this subject.

When the country samples of the CWP surveillance program are evaluated, it is seen that there is a significant decrease in the incidence of CWP and CWP-related mortality rates in the countries that carry out an effective surveillance program.[17,18] However, workplace health surveillance program in Turkey is carried out at intervals determined by the relevant laws, and the data obtained are not properly evaluated through an effective surveillance. It is expected that periodic health

surveillance programs that are made quite frequently and more (6-month intervals) compared with other countries will provide more effective results. In a study by Han *et al*.[6] on CWP, countries' health surveillance programs have been examined and chest radiograph has been seen to be recommended every 2–3 years in China,[19] 4–5 years in the USA, and every 6 years in Australia,[20] and it has been stated that there are major deficiencies regarding the comprehensiveness and implementation of occupational health and safety services throughout the country although it seems that China carries out health surveillance programs at more frequent intervals than Australia, and therefore, the CWP diagnosis is reported to be well below the actual figures. It is emphasized that what is important in these systems is the quality of the service provided and the control of the results.

Conclusion

The radiological assessment performed in accordance with the ILO standard within the scope of periodic medical examinations in the workplace is important for early diagnosis. Furthermore, screening programs should be evaluated with risk assessment and exposure information. Workplace physicians should re-evaluate the periodic examination and ILO assessment services in terms of technical and reader quality. The quality of service can be improved through internal auditing, such as re-evaluation of certified readers after the trainings. The results should be used to take the necessary measures to determine and control the risk. Otherwise, this assessment cannot go beyond the medical assessment that occupational health and safety professionals conduct to protect themselves, and nothing else can be achieved except the burden on both the employer and the national economy. Considering the results obtained in our study, CWP is still a significant disease in Turkey and both adjustments and improvements must be made regarding the CWP surveillance.

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Conflicts of interest

There are no conflicts of interest.

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