

Frequency of respiratory function disorders among dental laboratory technicians working under conditions of high dust concentration

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Abstract. – BACKGROUND AND OBJECTIVES: Dental laboratory technicians (DLTs) have much exposure to mineralogical dust that may have adverse effects on their lung health. The aim of our study was to investigate occupational dust exposure, and to determine the frequency of respiratory function disorders and radiologic abnormalities among DLTs.

MATERIALS AND METHODS: The study enrolled 94 DLTs who were exposed to dust in dental laboratories and 94 control subjects. Dust concentrations in the workplaces were measured.

RESULTS: The mean age of DLTs was 30.70 ± 9.84 years. No significant difference was found between the DLTs and the control groups for age or smoking status ($p > 0.05$). Spirometric values for the DLTs were found to be lower than the control group ($p < 0.05$). The mean working period for DLTs was 9.19 ± 5.9 years. The pulmonary function test results for the DLTs showed that 65.9% had a normal pattern, 22.4% were restrictive, and 11.7% showed obstructive type pulmonary function disorder. Negative correlations were found between the working period time and Forced Expiratory Volume in 1 second in the DLTs ($R = -0.675$ $p = 0.000$). Negative correlations were also found between working period time and Forced Vital Capacity in the DLTs ($R = -0.720$ $p = 0.000$). All DLTs had chest X-rays and 16 (17%) of them showed radiological pneumoconiosis.

CONCLUSIONS: This study showed a negative association between level of respiratory function and working period in DLTs.

Key Words:

Dental laboratory technicians, Pneumoconiosis, Respiratory function.

technicians work to create missing teeth by making appropriate prostheses using complementary materials². Lung fibrosis may be induced by breathing silica dust and probably also by the other dust particles generated during the production of dental prostheses, such as aluminium oxide, asbestos fibers, various metals (for example, cobalt chromium-nickel alloys and beryllium)³. This exposure may cause lung health problems including pneumoconiosis, hypersensitivity pneumonitis, lung granulomatosis, asthma, and lung cancer⁴⁻⁸.

Several studies have reported the effects of occupational exposure on lung health in DLTs.

However, in another study³, no significant differences in lung function or prevalence of respiratory symptoms were reported. Jacobsen et al⁹ found no difference in self-reported respiratory problems between DLTs and workers in other occupations. Selden et al¹⁰ showed that DLTs with at least 5 years of exposure to dust from cobalt-chromium-molybdenum alloys had pneumoconiosis. Several epidemiological studies have found a high level of pneumoconiosis among DLTs (9.8-24.2%)^{8,10-13}. A few studies have investigated the prevalence of pneumoconiosis in Turkey; and the prevalence was reported as 113.8-24.2%¹²⁻¹⁴.

In another report⁸ lung function levels were not significantly different between the DLTs and the controls, but the DLTs reported significantly more respiratory symptoms than the controls. In one investigation¹⁵ researchers found a significantly higher prevalence of respiratory symptoms in Korean dental technicians when compared with the controls. Radi et al¹¹ found that DLTs had significantly lower forced vital capacity (FVC) and maximal flow rate (at 25% and 50% respectively), against predicted values than did

Introduction

Dental laboratory technicians (DLTs) have much exposure to mineralogical dust that may have adverse effects on their lung health¹. Dental

control groups. Two researches were focused on respiratory symptoms or pneumoconiosis^{16,17}.

Dental technicians begin working at a young age. DLTs work in very small rooms, side by side and in a sitting position. All the stages of the creation of dental prostheses are manually manipulated. Thus, most of the process occurs in the respiratory zone (between the nose level and hands)².

The aim of our study was to investigate occupational dust exposure through a questionnaire, and to determine the frequency of respiratory function disorders and radiologic abnormalities among DLTs. We then evaluated the relationship between the working parameters and losses in respiratory function.

Material and Methods

Subjects

This study was carried out between February 2011 and May 2011 at the Department of Chest Diseases of Dicle University in the Diyarbakir province.

The study enrolled 94 DLTs who were habitually exposed to dust in dental laboratories. The control group was selected from a population not exposed to dust from a dental laboratory but living in geographic conditions similar to those in the Diyarbakir province. All the subjects were informed about the research and their written consent were given.

The control and study groups were similar in age, sex, height, and weight; 94 controls were en-

rolled. Subjects who had additional chronic lung disease, such as chronic obstructive pulmonary disease (COPD), clinical cardiovascular disorders, cardiac failure, hypertension, severe renal, hepatic or endocrine diseases, and systemic chronic diseases such as diabetes mellitus, neuromuscular dysfunction, malignancy, recent surgery or chronic renal failure were excluded from the study.

All the DLTs worked 6 days a week. The DLT group was sub-divided into two groups in relation to their period of working, as those who had worked ≤ 10 years and those who had worked >10 years.

Questionnaire

Physical examinations were performed, and a validated questionnaire, including questions about demographics and details of occupational exposure, was administered to all subjects. Chronic respiratory symptoms were recorded as cough, sputum, dyspnea and chest pain. A detailed occupational history, including period of working, working time in a day, and smoking habits, for all DLTs was recorded.

All subjects were examined and detailed clinical records of their history were obtained by a pulmonologist. In our Questionnaire there were 17 Questions (Appendix 1).

Radiologic Assessment

All subjects in both the DLT and control group were screened with a chest roentgenogram (CR), and two pulmonologists and one radiologist independently evaluated these chest X-ray images. The pulmonologists and radiologist did not have any

Appendix 1. Questionnaire of the study.

1. Record number:			
2. Group:	Dental Laboratory Technician (...) Control (...)		
3. Name-Surname:			
4. Age:	 Years		
5. Gender:	Male (...)	Female (...)	
6. Asbestos exposure:	Yes (...)	No (...)	
7. Biomass exposure:	Yes (...)	No (...)	
8. Period of working:	 Years		
9. Working time in a day:	 Hours		
10. Smoking habit:	Nonsmoker (...)	Smoker (...)	 Pack/years
11. Presence of dyspnea:	No (...)	Yes (...)	
12. Presence of cough:	No (...)	Yes (...)	
13. Presence of sputum:	No (...)	Yes (...)	
14. Presence of chest Pain:	No (...)	Yes (...)	
15. Physical examination of respiratory system:	Normal (...)	Abnormal (...)	 Findings = >
16. Evaluation of chest roentgenogram:	Normal (...)	Abnormal (...)	 Findings = >
17. Spirometric measurement:	FEV1 Liter %		
	FVC Liter %		
	FEV1/FVC Ratio %		

information about the clinical conditions of the subjects prior to the radiological examination. Consensus was defined as the median of the three readings. If there was an inconsistency among the readings for any reason, a second radiologist, who had no information about the initial readings, evaluated the films. Dust exposure induced pulmonary disease was assessed according to the International Labour Office (ILO, 2000) classification of pneumoconiosis¹⁸. Radiographs read as 0/0 and 0/1 were considered normal, while small irregular opacities graded 1/0, or higher than 1/0, were defined as pneumoconiosis.

Spirometric Measurements

A trained spirometry technician performed spirometric measurements with an automated spirometry device (Gold Pulmonary Analysis Computer, and Pulmograph, Wagner Road, Netherlands). Measurements, and the analysis of the spirometric data, were performed according to American Thoracic Society standards¹⁹. Forced Vital Capacity (FVC), Forced Expiratory Volume in 1 second (FEV₁), and the FEV₁/FVC ratio were measured, and the best value of three attempts was expressed as a percentage of the predicted value. Predicted values for FVC, FEV₁, and the FEV₁/FVC ratio, based on gender and height, were used to determine respiratory function.

Three basic patterns were recognized²⁰:

Normal pattern:

- FEV₁ and FVC above 80% of that predicted
- FEV₁/FVC ratio above 0.7

Obstructive pattern:

- FEV₁ below 80% of that predicted
- FVC normal or reduced – usually to a lesser degree than FEV₁
- FEV₁/FVC ratio below 0.7

Restrictive pattern:

- FEV₁ normal, or mildly reduced
- FVC below 80% of that predicted
- FEV₁/FVC ratio normal – above 0.7

Dust Measurement Method

In this study, we planned to measure the concentration of respirable particles of less than 10 µm (PM₁₀) that had been hanging in the air at the dental laboratory for a prolonged period and which, therefore, presented a dangerous condition for lung health. Dust concentrations were measured in the three laboratories involved in the study.

The Tecora Isostac Basic device, a Turkak-accredited Environmental Analysis Laboratory of Mechanical Engineers Chamber (TCR TECORA Srl, Corsico, Milan, Italy), was used in the dust measurement. Measurements were taken inside and outside the venue by attaching respirable dust (particle diameter < 10 µm) titles (PM₁₀) to the device, and working with the principle of gravimetric dust measurement. The measurement period was eight hours, and the device operated at a 1 m³/hour air suction speed.

Statistical Analysis

Statistical analyses were performed using the statistical package SPSS v12.0 (SPSS Inc., Chicago, IL, USA). Normality was checked for continuous variables. The appropriate non-parametric test was chosen for variables not normally distributed. Comparisons of continuous variables between the two groups were applied using Student's *t* test or the Mann-Whitney U test. Categorical variables between groups were analyzed using the chi-square test. Results were presented as *n*, percent, mean±SD (standard deviation), and median (minimum-maximum). Pearson's chi-square correlation test was used to investigate the correlation between the parameters. A *p* value of less than 0.05 was considered statistically significant.

Results

The results of the dust measurement in the three dental laboratories were found to be 2.182 mg/m³/24 hour, 1.826 mg/m³/24 hour and 1.935 mg/m³/24 hour.

The mean age of DLTs was 30.70±9.84 years (18-55). The control group consisted of 75 individuals with no symptoms and with a mean age of 31.45±7.96 years (23-49).

A total of 56 DLTs (59.6%) were smokers and 51 of the controls (54.2%) were smokers. No significant difference was found between the two groups for age or smoking status (*p* > 0.05).

The demographic data for the DLTs and control group were shown in Table I.

None of the subjects had a history of long-time exposure to biomass or to asbestos.

The Spirometric values of the DLTs were found to be lower than the control group (*p* < 0.05) (Table II).

The questionnaire revealed that 33 (35.1%) of the DLT subjects had chronic sputum history, 23 (24.4%) of the DLT subjects had chronic cough, 21 (22.3%) of DLT subjects had dyspnea, and 12 (12.7%) of DLT subjects had chest pain.

Table I. Demographic data of all subjects of study.

Features	Dental laboratory technician group (n = 94) n (%)	Control group (n = 94) (%)	p
Mean age (years)	30.70 ± 9.84	31.45 ± 7.96	NS
Gender			
Male	82 (87)	79 (84)	NS
Female	12 (13)	15 (16)	
Smoking status			
Smokers	56 (59.6)	51 (54.2)	NS
Non-smokers	38 (40.4)	43 (45.8)	
Mean smoking history (packet/years)	7.00 ± 8.16	7.69 ± 6.83	NS

NS = not significant ($p > 0.05$).

Physical examination revealed that seven subjects had bilateral fine crackles on the lung bases, and six subjects had expiratory rhoncus.

All subjects were working 6 days a week. The mean daily working time was 9.4 ± 1.5 hours.

The mean working period for the DLTs was 9.19 ± 5.9 years. The DLT group was divided into two groups for period of working, as being those who had worked ≤ 10 years and > 10 years and no difference was found between these two groups for frequency of symptoms, or for FEV₁, FVC, or FEV₁/FVC ratio ($p > 0.05$).

Pulmonary function test results for the DLTs showed that 65.9% had a normal pattern, 22.4% were restrictive, and 11.7% had obstructive type pulmonary function disorders.

Negative correlations were found between working period time and FEV₁ in DLT subjects ($R = -0.675$ $p = 0.000$) (Figure 1).

Negative correlations were found between the working period time and FVC in the DLTs subjects ($R = -0.720$ $p = 0.000$) (Figure 2).

All DLTs had chest X-rays and 16 (17%) of them showed radiological pneumoconiosis.

The frequency of radiological findings was not significantly different between the group with ≤ 10 years working time and the group of > 10 years working time ($p > 0.05$).

Discussion

This study showed the workplace level of PM₁₀ in three dental laboratories and measured the respiratory function of 94 DLTs in Turkey. We found that a high concentration of PM₁₀ was significantly associated with a decrease in FVC, FEV₁, and FEV₁/FVC.

The study showed a negative association between respiratory function and working period time among DLTs.

At present, routine air quality monitoring systems generate data based on the measurement of PM₁₀ as opposed to measurement of other particulate matter sizes. Consequently, the majority of epidemiological studies use PM₁₀ as the exposure indicator. PM₁₀ represents the particle mass that enters the respiratory tract. According to the world health organization (WHO), the PM₁₀ limit value is $< 50 \mu\text{g}/\text{m}^3/24$ hours mean²¹. The concentrations of PM₁₀ ranged from $1.826 \text{ mg}/\text{m}^3/24$ hours to $2.182 \text{ mg}/\text{m}^3/24$ hours for all samples, and the means were not significantly different between laboratories.

Dust levels have been measured in others reports and a study of dental laboratories in Seoul, Korea¹⁵ reported a mean concentration of $651 \text{ mg}/\text{m}^3$. Hu et al¹ reported that concentrations of

Table II. Comparison of laboratory parameters in dental laboratory workers and control groups.

Parameters	Dental laboratory workers (mean ± SD)	Control (mean ± SD)	p
FEV ₁ (l)	2.34 ± 0.76	3.16 ± 0.63	< 0.05
FVC (l)	2.73 ± 0.89	3.23 ± 0.82	< 0.05
FEV ₁ /FVC (%)	82.23 ± 16.82	84.42 ± 8.34	< 0.05

SD = Standard deviation; FEV₁ = forced expiratory volume in 1s; FVC = forced vital capacity.

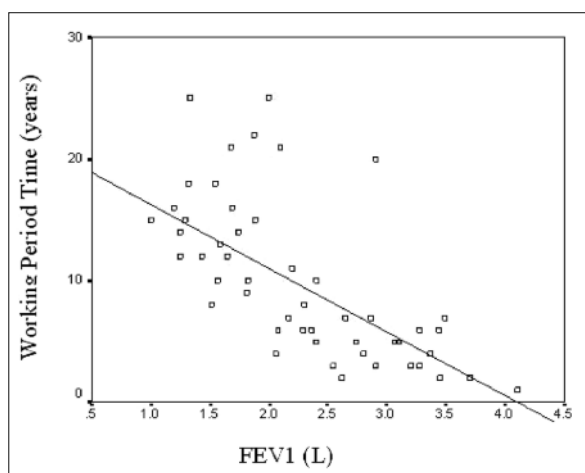


Figure 1. Correlation of FEV₁ level and working period time in dental laboratory technicians ($R = -0.675$ $p = 0.000$).

PM_{2.5} ranged from 26 mg/m³ to 664 mg/m³ with a mean of 106.99 mg/m³ for all samples, with the means significantly different between laboratories. In our study, the dust concentration in dental laboratories was found to be much higher than the limit values determined by the WHO.

Dental technicians may be exposed to silica dust and other airborne contaminants, although the risk of pneumoconiosis is well known³.

Previous investigations reported a pneumoconiosis rate of 4.5-23%^{2,3,11,14,22,23}. We found a pneumoconiosis rate of 17% among the DLTs. It was to be expected that this rate would be related to the length of working period with exposure to dust. However, we did not find a statistically meaningful relationship between pneumoconiosis rate and working period time.

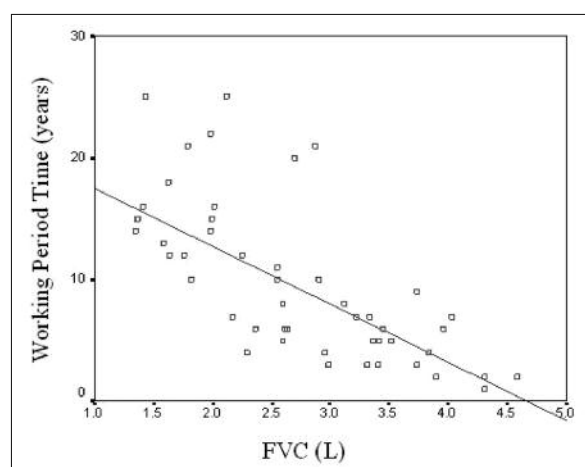


Figure 2. Correlation of FVC level and working period time in dental laboratory technicians ($R = -0.720$ $p = 0.000$).

Rom et al²² reported that the prevalence of respiratory symptoms was not higher among dental technicians than among controls. Other studies^{3,23} have not found significant differences in the prevalence of dyspnea in relation to the duration of exposure. Fidan et al²⁴ found that there is coughing in 19.12%, expectoration in 41%, and dyspnea and respiratory problems with growling, in 21.9% of dental technicians. Jacobsen et al²⁵ showed that respiratory problems were present in 16% of 201 dental technicians. Frodorakis et al⁸ reported statistically significant differences in respiratory symptoms when compared with a control group. Ozdemir et al¹⁴ reported that the prevalence of respiratory symptoms among both dental technicians and controls is high, but there is not a statistically significant difference between the two groups. In our study, the laboratory workers showed significantly higher levels of respiratory symptoms than the controls with chronic sputum 35%, chronic cough 24%, and dyspnea 22%.

Previous researches^{3,22,23} reported slightly lower lung function among dental technicians than among control subjects. Szadkowski et al²⁶ did not find any increased risk of impairment of lung function among the 149 dental technicians tested, probably because they did not compare their data with that of a control group. Some other studies^{7,8,13} reported spirometric parameters which did not show statistically important differences when compared with a control group.

Hu et al¹ found that PM_{2.5} was associated with a small, but not statistically significant, decrease in FVC, FEV₁, FEV₁/FVC, and FEF 25-75%, respectively, after controlling for smoking, duration of employment, having a cold, and the types of dental appliances made, and using the repeated measurement analysis.

These differences became significant in our work. Our findings appear to be consistent with previous reports of adverse effects on pulmonary function from the occupational exposure of dental technicians. However, previous investigations of respiratory health in dental technicians had utilized varying study designs and it was difficult to compare their results with ours.

Conclusions

In our region, the prevalence of pneumoconiosis is 17%. All our findings show that DLTs are at serious risk for respiratory system disorders.

Dental laboratory technicians generally work in small workplaces with poor quality air. Dust concentration in dental laboratories should be measured at technicians' working places and not be permitted to exceed the danger limits. All DLTs and managers of workplaces should be informed about the health problems related to dust exposure, and working conditions must be controlled.

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