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A LONGITUDINAL STUDY ON LUNG DISEASE IN DENTAL TECHNICIANS: WHAT HAS CHANGED AFTER SEVEN YEARS?

DERYA ÖZDEMIR DOGAN[1], SERDAR BERK[2], CESUR GUMUS[3], ALI KEMAL OZDEMIR[1], and IBRAHIM AKKURT[2]

[1] Cumhuriyet University, Sivas, Turkey
Department of Prosthodontics, Faculty of Dentistry
[2] Cumhuriyet University, Sivas, Turkey
Department of Chest Diseases, Faculty of Medicine
[3] Cumhuriyet University, Sivas, Turkey
Department of Radiology, Faculty of Medicine

Abstract
Objectives: The aim of this 7-year follow-up study was to determine respiratory changes in dental technicians. **Material and Methods:** In our region, in the year 2005, 36 dental technicians were evaluated with a cross-sectional study on respiratory occupational diseases, and in 2012 we evaluated them again. Inclusion of information on respiratory symptoms and demographic features questionnaires was applied. Pulmonary function tests (PFT) were performed. Chest X-rays (CXR) were evaluated according to the ILO-2000 classification. For the comparisons of the technicians' findings in 2005 and 2012, data analyses were performed with the Wilcoxon test in addition to descriptive statistical procedures. **Results:** In 2012, 19 out of the 36 technicians continued to work in the same place, so we were able to evaluate their findings. The prevalence of respiratory symptoms in dental technician was as follows: dyspnea 7 (37%), cough 6 (32%), and phlegm 5 (26%). According to ILO classifications in 2005, among the 36 technicians, 5 (13.8%) had pneumoconiosis. At the end of 7 years, there were 9 pneumoconiosis cases among the 19 remaining technicians (47%). Thus, there was a statistically significant progression on the profusion of the radiologic findings ($p < 0.005$). Also there was a significant worsening on spirometric findings ($p < 0.05$). **Conclusion:** In dental technicians, a determination of both radiologic and functional progressions at the end of 7 years demonstrate that the primary and secondary preventive measures are necessary for these workplaces. Workplaces must be regularly controlled for worker health and hygiene.

Key words:
Pneumoconiosis, Dental laboratory technicians, Occupational respiratory diseases

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Corresponding author: S. Berk, Department of Chest Diseases, Cumhuriyet University, TR-58140 Sivas, Turkey (e-mail: serdar.berk@yahoo.com; serdar_berk@mynet.com).

INTRODUCTION

Dental laboratories carry many potential occupational risks for dental technicians. They have multiple occupational exposures (silica, hard metals, dental alloys, acrylic resins etc.) that may have adverse effects on their health [1,2]. When insufficient workplace airing and the lack of preventive measures are added to this exposure, the risks become much greater. The interstitial disease caused by exposure to the complex substances used by dental technicians is classified as a special group called dental technician's pneumoconiosis [3,4]. Pneumoconiosis among dental technicians has recently emerged as an area of research in interstitial lung disease. Several studies have been carried out to investigate pneumoconiosis and lung function abnormalities among dental technicians, and several epidemiological studies indicate a high range of pneumoconiosis (4.5–38.6%) [2–5]. But almost all of them are cross-sectional studies such as our previous study [6]. Nevertheless, long-term follow-up studies in this occupation are insufficient. For this reason the aim of this 7-year follow-up study was to determine respiratory changes in dental technicians compared to our first study. To our knowledge, this is the first study in the literature in English that evaluates long-term findings on dental technicians.

METHODS

We evaluated 36 dental technicians who worked in small enterprise workplaces in the Sivas province area in 2005 on their occupational exposure and their clinical, radiological and functional findings [6]. In 2012, we were able to reach 19 of them again. Although all of the technicians were warned about bad working conditions in the workplace in terms of their health problems, it was determined that all 19 of them continued to work in the same conditions. We were not able to obtain any information on the fate of the others, so, this study included only these 19 persons.

To study them, we used the same method that we used in the first study [6]. All subjects gave their informed consent before the study began, and the study was approved by the Human Ethics Committee of our university. Information on respiratory symptoms, smoking status, age, and sex was collected with a modified version of the Occupational and Environmental Pulmonary Disease Evaluation Questionnaire of the Turkish Thoracic Society Environmental and Occupational Pulmonary Diseases Working Group [7]. The questionnaires were applied to the subjects by a physician face to face.

All pulmonary function tests (PFTs) were performed according to the American Thoracic Society Guidelines [8]. The Forced Vital Capacity (FVC) manoeuvre was applied in the case all of the subjects according to the standard procedure. Posterior-anterior chest X-rays were taken in our radiology department. Short exposure time and high voltage techniques were used to take X-rays. (Toshiba, kwo-50F, Tokyo, Japan). X-rays were evaluated according to the ILO-2000 classification by three readers in the same manner as in the first study. According to the ILO classification 1/0 an upper profusion is considered to be pneumoconiosis [9–11]. All of the new findings were compared to the former outcomes. All of the CXR were quality 1 or 2 according to ILO classification. All of the X-ray findings according to profusion scores were changed to numeric values for statistical comparison, and the average ILO profusion score was calculated according to a 12-point scale (Table 1) [12,13].

Statistical analysis

Data are presented as a mean ± standard deviation (SD) and percentage as appropriate. For the comparisons of the technicians in 2005 and 2012, data analysis was performed with the Wilcoxon Test and McNemar's Test. Spearman's rank correlation test was used to investigate

Table 1. Codification of the International Labour Organization profusion, sub-profusion categories and profusion score according to 12-point scale

Categories	0			1			2			3		
Sub-categories	0/–	0/0	0/1	1/0	1/1	1/2	2/1	2/2	2/3	3/2	3/3	3/+
Profusion score	1	2	3	4	5	6	7	8	9	10	11	12

the relationship between variables. A p value of < 0.05 was accepted as statistically significant.

RESULTS

A longitudinal study was performed for the 19 dental technicians. We compared all of the findings of our earlier cross-sectional study results to the new data. All participants were male. In 2012, the mean age of the technicians was 36.5 years (min: 25; max: 59), and the mean working time was 20.4 years (min: 6; max: 40). Fifteen (79%) technicians had a smoking history with a mean of 16±15 years of smoking. The prevalence of respiratory symptoms in dental technicians was as follows (2005/2012); dyspnea 6/7, cough 6/6 and phlegm 7/5, respectively. Table 2 shows the demographic and clinical characteristics of the technicians in 2012.

Table 2. Current characteristics of the population (2012)

No	Age (year)	Employment duration (year)	History of smoking (pack-year)	Dyspnea	Cough	Phlegm
1	37	20	10	+	+	–
2	32	18	–	–	–	–
3	29	17	12	–	–	–
4	36	23	17	+	+	+
5	34	17	19	–	+	–
6	28	8	10	–	–	–
7	40	23	30	+	–	–
8	31	11	36	–	–	–
9	43	24	30	+	+	+
10	42	26	20	–	–	–
11	59	40	–	+	+	–
12	41	20	–	–	–	–
13	27	10	9	+	+	+
14	25	10	–	–	–	–
15	34	20	9	–	–	–
16	30	12	24	–	–	–
17	37	22	6	–	–	–
18	42	25	24	–	–	+
19	47	37	44	+	–	+

According to the ILO 2000 classification 1/0 (score 4) and higher is considered to be pneumoconiosis. Lesions in accord with pneumoconiosis were radiologically determined in 5 out of 36 workers (13.8%) 7 years ago. In 2012, opacity in accord with pneumoconiosis was determined in 9 out of 19 patients (including the previous 5 patients with pneumoconiosis). This increase was statistically significant ($p = 0.001$). Moreover, in 2005, radiological progression was determined in 4 out of 5 patients with pneumoconiosis. After the period of seven years, there was a radiological increase in the profusion category for 7 (37%) of the 19 workers (Table 3).

There was found to be a statistically significant progression from 2005 to 2012 in profusions of the radiologic findings ($p < 0.005$). Spirometry evaluation suggested that small airways were especially affected, with a statistically significant worsening ($p < 0.05$) (Table 4).

The analysis of the data from 2005 showed that there was a positive correlation between the ILO profusion scores and the number of working years ($r = 0.702$, $p = 0.001$),

Table 3. Radiological features of the technicians

No	Parenchymal opacity		Profusion sub-categories		ILO profusion score		Profusion categories	
	2005	2012	2005	2012	2005	2012	2005	2012
1	r/q	r/q	2/1	3/2	7	10	2	3
2	p/s	p/s	0/1	0/1	3	3	0	0
3	–	p/q	0/–	0/1	0	3	0	0
4	p/s	q/t	1/0	3/3	4	11	1	3
5	–	–	0/–	0/–	1	1	1	0
6	–	–	0/–	0/–	1	1	0	0
7	p/p	p/s	0/1	1/1	3	5	0	1
8	–	p/q	0/–	1/0	1	4	0	1
9	t/q	t/q	2/2	2/3	8	9	2	2
10	p/p	–	0/1	0/–	3	3	0	0
11	r/q	r/t	2/3	3/2	9	10	2	3
12	–	p/s	0/–	0/1	1	3	0	0
13	–	p/s	0/–	1/1	1	5	0	1
14	–	–	0/–	0/–	1	1	0	0
15	–	–	0/–	0/–	1	1	0	0
16	–	–	0/–	0/–	1	1	0	0
17	–	p/s	0/–	0/1	1	3	0	0
18	–	p/s	0/–	1/0	1	4	0	1
19	t/q	p/q	1/2	1/2	6	6	1	1

ILO – International Labour Organization.
p – round opacities up to 1.5 mm in diameter.
q – round opacities 1.5–3 mm in diameter.
r – round opacities 3–10 mm in diameter.
s – irregular opacities with widths up to about 1.5 mm.
t – irregular opacities with widths exceeding about 1.5 mm and up to about 3 mm.

Table 4. Comparison of the chest x-ray and spirometry results of the technicians in 2005 and 2012

Parameters	Results (M±SD)		p
	2005	2012	
ILO profusion score	2.80±2.70	4.40±3.30	0.003*
FVC (ml)	4.48±0.94	4.26±1.20	0.795
FVC (%)	94.00±18.00	95.00±14.00	0.309
FEV_1 (ml)	3.86±0.81	3.63±0.66	0.142
FEV_1 (%)	96.00±18.00	93.00±14.00	0.758
FEV_1/FVC	86.00±8.00	83.00±70.00	0.052
$FEF_{25–75}$ (ml)	4.85±1.40	3.94±1.00	0.010*
$FEF_{25–75}$ (%)	103.80±30.00	87.00±21.00	0.020*
PEF (ml)	8.64±1.89	7.73±2.10	0.022*
PEF (%)	92.50±20.00	84.10±22.00	0.041*

* $p < 0.05$.
ILO – International Labour Organization.
M – mean; SD – standard deviation.
FVC – forced vital capacity.
FEV_1 – forced expiratory volume in 1 second.
FEV_1/FVC – forced expiration rate.
FEF – maximal flow at 25–75% expired vital capacity.
PEF – peak expiratory flow.

whereas there was a negative correlation between the ILO profusion scores and FEV_1 ($r = –0.552$, $p = 0.001$). Similarly, in 2012 the positive correlation between the ILO profusion scores and the number of working years continued ($r = 0.572$, $p = 0.01$), and the negative correlation between the ILO profusion scores and FVC% and $FEV_{1\%}$ was determined ($r = –0.528$, $p = 0.02$; $r = 0.555$, $p = 0.02$, respectively). Furthermore, the analysis showed that there was a negative correlation between the working years and FVC% and $FEV_{1\%}$ ($r = –0.545$, $p = 0.02$; $r = –0.503$, $p = 0.03$, respectively).

DISCUSSION

Many studies in the literature demonstrate potential hazards for dental technicians related to their working conditions [1–6,15–24]. Most of the studies have related to the determination of the prevalence of pneumoconiosis such as our first cross-sectional epidemiologic study [6]. But, to our knowledge, there are no longitudinal-cohort studies to show these effects in the literature in English. So, we think that this is the first study of its kind. Our study group was a subset of the same group, which was studied 7 years ago. In the dental technicians group, the prevalence of pneumoconiosis was 13.8% in our first study group in 2005, but currently it is 47% (9/19). Moreover, an increase in ILO profusion scores was determined in the CXR of 4 out of 5 cases in which pneumoconiosis was diagnosed radiologically in 2005.

In the English literature, long-term follow-up studies in terms of pneumoconiosis in dental technicians were not found. However, there were several studies showing progression of pneumoconiosis over time in various occupations that involve similar exposure to inorganic dust, that investigated the factors associated with progression. In a study from Scotland, in the examination of chest radiography of 547 colliery workers after 20 years, radiological progression was found in 38% of the workers according

to the 12-point ILO profusion scale [14]. In a cohort study of granite workers exposed to silica, in 37% of workers, who were followed up for a mean of 7.5 years (minimum 2 years, maximum 17 years), radiological progression of silicosis was observed [15]. In another study by Maclaren et al. on 4772 old colliery workers, it was stated that age, previous pneumoconiosis category, and dust exposure time were decisive in the development of progressive massive fibrosis [16].

In our study, our study population consisted of younger dental technicians exposed to dust. After seven years, a significant increase was observed in pneumoconiosis prevalence. Moreover, in the category of radiologic profusion of 7 workers (37%), at least one increase in a category was found. This result can be related to continuation of dust exposure despite informing the workers about the need to improve air ventilation conditions of their workplaces in 2005. On the other hand, even if the dust exposure ends, it has been reported that pneumoconiosis may progress. In a recent study from Japan, pneumoconiosis progressed radiologically by 62% in the first ten years and by 29% at the end of 20 years in retired coal workers with coal worker's pneumoconiosis whose exposure to dust ended [17]. For this reason, we can say that in such occupations, where the dust exposure is either continued or ended, a periodical check-up for pneumoconiosis is recommended.

In the literature there are different results about the relationship between the working time of dental technicians and pneumoconiosis prevalence. Among the people having approximately 19 to 20 years of average working time, pneumoconiosis prevalence was found to be 12.9% and 9.8%, respectively, in two different studies performed by Sherson et al. [18] and Froudarakis et al. [19]. Pneumoconiosis prevalence in dental technicians having an average of less than 10 years of working time was stated to be 24.2% in a study in Turkey [20]. In another study, while pneumoconiosis prevalence in dental technicians having less than 30 years of working time was found to be 3.5%, and it was found to be 22,2% in those having a work history of more than 30 years [21].

The difference between these results might be based on both, the method difference of the studies and the difference in workplaces and conditions of the technicians. On the other hand, in our study, while pneumoconiosis prevalence in the dental technicians having an average working time of 13 years was 13.8% in 2005; 7 years later, both, the number of those diagnosed with pneumoconiosis and the parenchymal opacities of those previously diagnosed with pneumoconiosis, increased. The highest category was 3/3, and there was only one case in this category. And, this case's X-ray profusion category was 1/0 seven years ago. The results demonstrate that the respiratory exposure of technicians in our working population continues, and rapid progress of the pneumoconiosis occured over 7 years, i.e. a short time. We think that this is a very valuable finding because it shows that not stopping exposure induced very important pathological changes in lung tissue. To our knowledge, this is the first time that such findings in the literature have been written up in English.

Varying results have been obtained from the literature studies that address the relationship between dental technician's pneumoconiosis in terms of respiration symptoms, physical examinations, and radiological findings. Cimrin et al. found in their study that radiological findings were correlated with pneumoconiosis in 33 (23.6%) workers. Pneumoconiosis frequency was 50.0% in workers with sandblasting histories. There was no significant correlation between pneumoconiosis and cough, sputum, dyspnea, wheezing, physical examination findings, and tenure [22]. Jacobsen et al. showed that respiration problems were present in 16% of 201 Norwegian dental technicians [23]. Radi et al. indicated that coughing and expectoration were major symptoms in dental technicians [24]. Meanwhile, Froudorakis demonstrated statistically significant differences in respiration symptoms compared with the control group [17]. Sherson et al. did not indicate

any statistical difference but, they noticed higher dyspnea scores in a dental technicians group [18]. In our study, dyspnea 7 (37%) was the major symptom among dental technicians. A statistical analysis could not be carried out due to the number of cases being small. Meanwhile, we have also found that all of the patients who described symptoms of dyspnea had an ILO profusion score of 4 and above. It has also been found that no significant change took place in respiration symptoms after 7 years.

The data related to airway interactions in the dental technicians are controversial. Woan et al. conducted a study on 11 dental technicians in Taiwan whom they studied for more than 10 years, and they found a small decrease in FVC and FEV_1 when compared with the control group, which is statistically not important [1]. Choudat et al. performed a study in which they examined respiratory symptoms and lung functions on 105 dental technicians living in Paris [1,2]. These subjects' PFT values were not statistically different from the control group, but 11.8% of the subjects showed radiological abnormalities that were consistent with dental technician's pneumoconiosis. While a significant relationship between working times and interstitial opacity was determined as a result of a recent study conducted among 42 dental technicians in Iran, no correlation could be found to exist between working times and spirometry parameters [25]. In our study, a considerable decrease was found in the PEF and $FEF_{25–75}$ values of 19 cases as a result of the PFT analysis that was carried out 7 years later. It is thought that this finding reflects an obstructive disorder.

Additionally, the data from 2005 showed a negative correlation between radiological opacity density and FEV_1. However, after seven years, the data from 2012 showed that in addition to FEV_1, there was a negative correlation with FVC, too. Based on this study, it can be concluded that the increase in radiological opacity density is in parallel to the number of working years. However, the fact that other infectious and non-infectious causes cannot be fully excluded and that almost 80% of the technicians have a history of smoking weakens our argument.

The primary limitations of our study include the possible differences between CXR readers, the small number of cases due to the inability to contact all technicians, and the lack of a control group. Nevertheless, our study is of importance as it is the first piece of research at the moment that examines the radiological and functional changes in respiratory systems of dental technicians at the end of a period of seven years, after having worked consistently at the same workplace and under the same working conditions.

CONCLUSIONS

In conclusion, in our region, the prevalence of pneumoconiosis increased from 13.8% to 47% among dental technicians during the 7 years between the two studies. Dental technicians should be informed to take precautions against high dust measurements in their workplaces and not to allow them to exceed danger limits. Dental laboratory technicians are at significant risk of occupational respiratory diseases, so the primary rules for prevention are essential for these workplaces. Moreover, such workplaces must be regularly controlled for worker health and hygiene.

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