Lung Cancer Risk in Male Dentists: A Retrospective Cohort Study in Japan, 1964–1997

Nobuhiro NISHIO1, Hideo TANAKA2, Hideaki TSUKUMA2 and Rikio TOKUNAGA1

1Department of Hygiene, Kansai Medical University and 2Department of Cancer Control and Statistics, Osaka Medical Center for Cancer and Cardiovascular Diseases, Japan

Abstract: Lung Cancer Risk in Male Dentists: A Retrospective Cohort Study in Japan, 1964–1997: Nobuhiro NISHIO, et al. Department of Hygiene, Kansai Medical University—It is reported that dentists are exposed to heavy metals in their clinics. To assess the risk of developing lung cancer among male Japanese dentists, we conducted a retrospective cohort study of 3,314 members of Osaka Dental Association (Osakafu-Shikaishikai). During 1964–1997, 39 were diagnosed with lung cancer, which figure was obtained from the file of the Osaka Cancer Registry. The observed number of lung cancers was compared with the expected number calculated by multiplying the number of person-years at risk by the corresponding age- and calendar time-specific incidence rate from the Osaka Cancer Registry data. The male dentists had no significantly different risk than general population (O/E=1.01, 95%CI=0.72–1.39). Contrary to expectation, these findings indicate that Japanese dentists had almost the same overall risk of developing lung cancer as the general population.

(J Occup Health 2004; 46: 37–42)

Key words: Incidence, Dentist, Lung Cancer, Cancer Registry, Epidemiology

Lung cancer has been a leading cause of cancer death among male Japanese since 19931. Although tobacco use is a major risk factor, many occupational agents, such as asbestos, arsenic, beryllium, hexavalent chromium, cobalt and nickel have been recognized to cause or suspected of causing lung cancer2,3.

Dentists and dental technicians have used, Beryllium (Be), Chromium (Cr), Copper (Cu), Gold (Au), Iridium (Ir), Iron (Fe), Mercury (Hg), Molybdenum (Mo), Nickel (Ni), Niobium (Nb), Palladium (Pd), Platinum (Pt), Scandium (Sc), Silver (Ag), Tin (Sn), Titanium (Ti), Zinc (Zn), metallic resins and acrylic resins as dentures, plugging, adhesives and so on. Case reports indicated the dust generated through grinding metallic dental materials has caused lung disorders in dentists, dental students and dental technicians4–9). It is reported that respiratory dusts are generated at dental clinics during treatment and dental laboratory work in Japan10–14). Dentists have inhaled and will inhale the dust of those agents through the airways during their treatment and dental laboratory work.

In the past studies on dentists in Japan, there was no observation of lung cancer morbidity or a well-designed cohort study to assess the risk of lung cancer. There are only two assessments using the standardized mortality ratio in cross-sectional study of lung cancer15, 16). Previous studies reported that SMR of lung cancer for male dentists were 0.71 (Niwa) and 0.96 (Ikuta). Niwa said that the lower mortality rate may be influenced by the healthy worker effect, which reduces the mortality risk in occupational populations, when compared with the general population17). We planned this retrospective cohort study, suspecting that lung cancer morbidity in dentists is higher than in the general population, because of occupational exposure to dental materials. The morbidity rate is probably less influenced by the healthy worker effect, than in the study of the mortality rate.

Since there have been several changes in dental treatment procedures and materials used in crowns, dentures or plugging in the past 30 yr in Japan, a long term follow up study is needed to assess the risk of lung cancer by the period of observation or by a birth cohort.

Osaka Dental Association is one of the biggest groups of Japanese dentists, and its membership covers more than 90% of the dentists working in Osaka Prefecture (Personal communication from Osaka Dental Association and Japan Dental Association). We conducted a long-term retrospective cohort study to assess the lung cancer incidence among dentists in comparison with the general
Subjects and Methods

The cohort comprised members of the Osaka Dental Association identified from membership files available since 1960. The membership of Osaka Dental Association covers approximately 90% of dentists who work in Osaka Prefecture, which had 8.7 million residents in 1995. Each record contains information about name, address, sex, birthdate, date of joining the Osaka Dental Association and the date of leaving the Osaka Dental Association. Almost every dentist in Osaka joins the Osaka Dental Association immediately after he/she gets the national license for dentists. Membership expires when they move outside Osaka Prefecture, finish their dental work for some reason or when they die.

In the membership file, we excluded: ➀ 103 leaving the Osaka Dental Association before 1964, ➁ 1814 joining the Osaka Dental Association after 1985, ➂ 806 aged 50 or older on January 1, 1964, when the data of the Osaka Cancer Registry (OCR) became freely available, ③ 256 female members, ④ 357 residents outside Osaka Prefecture, and ⑤ 18 members whose date of leaving the Osaka Dental Association was not known. The remaining 3,314 members were eligible. The subjects comprised 1,033 dentists alive on January 1, 1964, who had joined as a member of the Osaka Dental Association, and 2,281 dentists who had joined the Osaka Dental Association between January 1, 1964 and December 31, 1985. The date of entry into the study was January 1, 1964 for the first group and the date of joining the Osaka Dental Association for the second, respectively.

A follow up was performed by linking to the file of OCR using the subject’s name, sex, birth date and address. The OCR has been operating since 1962, registering all cancer cases in reports from hospitals and clinics and death certificates collected from the Osaka Prefectural Government. The end of the follow up was the date of leaving the Osaka Dental Association including the date of death, the date of diagnosis of lung cancer or December 31, 1997, whichever occurred first.

The number of lung cancer cases observed was compared with the expected number, which was calculated by five-year age- and five-year calendar time specific incidence rates for the general population of Osaka, which were prepared by the OCR. Statistical tests of the ratio of observed to expected numbers (O/E ratio) were based on the assumption that the observed number followed a Poisson distribution. If the 95% confidence interval (CI) did not include 1.00, the O/E ratio was considered to be statistically significant (P<0.05).

Results

The birth year of 3,314 members varied from 1914 to 1959, and their mean age at the beginning of the follow up was 32. They contributed 78,210 person years of observation from the mean length of follow up was 23.6 yr (Table1). Twelve percent (392/3314) of the members died during the follow up. We identified 39 members diagnosed with lung cancer. The risk of developing lung cancer was almost the same as unity (O/E=1.01, 95% CI=0.72–1.39). When the risk of developing lung cancer was calculated with the 4 birth cohorts (1914–19, 1920–29, 1930–39 and 1940–1959), no significant increased risks were founded (O/E=0.33–1.34, Table1). Also, there was no statistically increased risk of developing lung cancer in the every follow up (Table2).

### Table 1. Observed (O) numbers and risk ratio (O/E) of lung cancer in members of the ODA* according to the birth cohort

<table>
<thead>
<tr>
<th>Birth year</th>
<th>n</th>
<th>Mean age at the beginning of follow up (S.D)</th>
<th>Mean length of follow up (yr)</th>
<th>O</th>
<th>O/E (95% CI)</th>
<th>Mean age at the time of diagnosis of lung cancer (S.D)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1914–19</td>
<td>170</td>
<td>46.7</td>
<td>27.1</td>
<td>10</td>
<td>1.09</td>
<td>71.4</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(1.8)</td>
<td>(8.3)</td>
<td></td>
<td>(0.52–2.01)</td>
<td>(6.2)</td>
</tr>
<tr>
<td>1920–29</td>
<td>587</td>
<td>38.2</td>
<td>30.2</td>
<td>17</td>
<td>0.94</td>
<td>61.7</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(3.0)</td>
<td>(7.0)</td>
<td></td>
<td>(0.55–1.50)</td>
<td>(8.4)</td>
</tr>
<tr>
<td>1930–39</td>
<td>738</td>
<td>30.9</td>
<td>30.2</td>
<td>11</td>
<td>1.34</td>
<td>57.5</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(3.8)</td>
<td>(5.5)</td>
<td></td>
<td>(0.67–2.41)</td>
<td>(6.7)</td>
</tr>
<tr>
<td>1940–59</td>
<td>1,819</td>
<td>28.7</td>
<td>18.4</td>
<td>1</td>
<td>0.33</td>
<td>51.0</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(2.8)</td>
<td>(5.8)</td>
<td></td>
<td>(0.00–1.84)</td>
<td>(–)</td>
</tr>
<tr>
<td>Total</td>
<td>3,314</td>
<td>31.8</td>
<td>23.6</td>
<td>39</td>
<td>1.01</td>
<td>62.7</td>
</tr>
</tbody>
</table>

S.D: Standard deviation, 95%CI: 95% Confidence Interval, *: Osaka Dental Association
Discussion

The results of this study show that there is no significant difference in lung cancer risk between male members of Osaka Dental Association and the general population in Osaka (O/E=1.01, 95% CI=0.72–1.39). We did not observe the increased risk of lung cancer that we suspected beforehand. There was also no statistically increased risk of developing lung cancer in every birth cohort or in every follow up. There are a few cohort studies about on the morbidity of lung cancer in dentists. According to previous studies in Finland18) and Sweden19), no increased risk was observed.

Sakuraba reported large amounts of respiratory dusts generated in dental operating rooms and scattered around the operator during treatment11). The work of dentists includes dental laboratory work. In Japan, approximately 10% of crowns or porcelain fillings are manufactured by dentists themselves and 90% of them are manufactured by dental technicians20). It is considered that, in the past, dentists did more portion of this kind of work21). Brune and Fukuzawa reported that respiratory dusts, including chrome, cobalt and nickel, were generated in the dental laboratory room, and measured the volume12–14, 22–24). Dentists have inhaled and will inhale the dust of those agents through the airways during their treatment and dental laboratory work.

Ohmori reported that chromium, cobalt and nickel are present in the hair of dental technicians more than in other occupational workers25). It has been observed that there is more chromium and cobalt in the lung tissue of dental technicians than in other occupational participants25–29). It is reported that several dental technicians were positive in a lymphocyte transformation test which is a technique for evaluating sensitization to beryllium30). Kotloff reported a dental technician who developed chronic beryllium disease as a result of exposure in the workplace31).

Workers in the primary chromate production industry and chromate pigment industry have consistently shown risks of lung cancer32–42). Workers in these industries may be exposed to a variety of forms of chromium, including hexavalent [VI] and trivalent [III] chromium compounds43). Chromium [VI] is carcinogenic to humans, but it is reported that dental materials, for example chromium-cobalt alloy, include a little43). IARC lists chromium [III] as Group 2B (possibly carcinogenic to humans)43). A TLV-TWA (Threshold Limit Value-Time Weighted Average) of 0.5 mg/m³, as metal and trivalent chromium compounds, is recommended to minimize the potential risk of respiratory disorder, by ACGIH44).

Epidemiological and experimental observations show that cobalt will be carcinogenic in the human lung32, 45). IARC lists cobalt as Group 2B (possibly carcinogenic to humans)43). Exposure to 0.1 mg/m³ or less of cobalt metal and inorganic compounds of cobalt caused asthma and changes in pulmonary function44). Some experiments show that large volume cobalt exposure caused lung cancer in animals, but the human threshold of carcinogenesis is unknown. A TLV-TWA of 0.02 mg/m³, as cobalt, is recommended to minimize the potential risk of developing asthma, pulmonary malfunction and myocardial effects, by ACGIH.

Occupational exposure to nickel in nickel smelters and refineries is associated with an increase in cancer of the lungs and the nasal sinuses32, 33, 42, 46–48). Nickel compounds and metallic nickel have been classified as Group 1 (carcinogenic to humans) and Group 2B (possibly carcinogenic to humans) by IARC, respectively43). It is reported that respiratory cancer risks in nickel refinery workers were preliminary related to exposure to excess of 1 mgNi/m³ for soluble nickel and 10 mgNi/m³ for insoluble nickel44).

Follow-up studies have revealed that individuals with chronic beryllium disease have a higher incidence of lung cancer than the general population. IARC lists beryllium as Group 1 (carcinogenic to humans)43). There have been two reports in which workers with apparent exposure below the current TLV of 0.002 mg/m³ developed chronic beryllium disease49, 50). A TLV-TWA of 0.002 mg/m³, as beryllium, is recommended by ACGIH to minimize the likelihood of developing chronic beryllium disease and potential lung cancer.

Kidokoro and Amano observed the work of dentists

Table 2. Observed (O) and expected (E) numbers of lung cancer in members of ODA according to the number of years since the beginning of the follow up

<table>
<thead>
<tr>
<th>Duration (yr)</th>
<th>O</th>
<th>E</th>
<th>O/E</th>
<th>95% CI</th>
</tr>
</thead>
<tbody>
<tr>
<td>0–3</td>
<td>0</td>
<td>0.07</td>
<td>0.00</td>
<td>0.00 – 49.65</td>
</tr>
<tr>
<td>1–4</td>
<td>1</td>
<td>0.47</td>
<td>2.13</td>
<td>0.03 – 11.85</td>
</tr>
<tr>
<td>5–9</td>
<td>2</td>
<td>1.29</td>
<td>1.55</td>
<td>0.17 – 5.59</td>
</tr>
<tr>
<td>10–14</td>
<td>3</td>
<td>2.99</td>
<td>1.00</td>
<td>0.20 – 2.93</td>
</tr>
<tr>
<td>15–19</td>
<td>7</td>
<td>5.10</td>
<td>1.37</td>
<td>0.55 – 2.83</td>
</tr>
<tr>
<td>20–26</td>
<td>28</td>
<td>28.55</td>
<td>0.91</td>
<td>0.59 – 1.33</td>
</tr>
</tbody>
</table>
and reported that grinding work is limited to 30 min at longest per day, and dental laboratory work to 2 h at longest per day\textsuperscript{51, 52}. Their working time is shorter than that of chromate workers et al. According to Fukuzawa, the volume of exposure to dusts (Cr<0.01–0.01 mg/m\textsuperscript{3}, Co 0.01–0.10mg/m\textsuperscript{3} with a local exhaust system) is smaller than that of hard metal workers. It is observed that the relative risk in Japanese males is reported to be about 4 to 5 at 1964–66). The smoking rate for Japanese males reached its highest point in 1966, and thereafter it has been decreasing, so that it was down to 56% in 1997\textsuperscript{60}. It is supposed that smoking by most males in Osaka Prefecture is similar with that of Japanese males in general. If the relative risk of lung cancer due to smoking in the study subjects was same as in Japanese males in general (4.5), and the study subjects had a lower smoking rate (40%) than that in the same birth cohort of male Osaka residents (70%), the expected number of lung cancers (E) is calculated to be 26.96. As a result, the O/E ratio is increased to 1.45.

Our results do not show an increased risk of lung cancer in male Japanese dentists, but, on the basis of our data, it is necessary to conduct further study on the risk of lung cancer in dentists correcting with their smoking habit.

Acknowledgments: We thank Ms. Yasue Kotani and the stuff of the Osaka Dental Association for their technical assistance. We thank Dr. Kenji Wakai for his kind suggestion. This study was supported in part by a Grant-in-Aid for Cancer Research from the Japanese Ministry of Health, Welfare and Occupation (8–2).

References

1) Vital Statistics. Statistics and Information Department, Ministry of Health, Labour and Welfare, Japan
11) Y Sakuraba, A Magoshi, H Okada, M Morimoto and


20) Japanese Medical and Dental Practiccional for the Improvement of Medical Care: Survey on Self-employed Medical Doctors and Dentists. Gekkann Hodanren No.700 (2001)


44) American Conference of Government Industrial Hygienists: Documentation of the Threshold Limit Values and Biological Exposure to Indices 7th Ed. ACGIH, Cincinnati 2001

45) JJ Moulin, P Wild, S Romanzini, G Lasargues, A Perdrix, A Peltier, C Bozec, P Deguerry and F Pellet:
42


52) I Amano: Hygiene of Denstry. Shikageppo 30, 63–82 (1956)


54) Y Suyama: Dental laboratory processing dusts and the health maintenance. The Journal of Dental Technology 14, 1037–1039 (1986)


58) Smoking Survey in Osaka. Osaka Prefecture 1997


60) Japan Smoking Rate Survey. Japan Tobacco Inc.

61) Hirayama T. Life style and mortality, a large-scale census-based cohort study in Japan. Basel: Kargel 1990

