SHORT COMMUNICATION

Deposits of various metallic dusts observed at autopsy in a dental health care worker with lung cancer

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Introduction

In dental clinics and laboratories, dental care workers are likely to inhale dusts of various metals and resins ground for the preparation of dental prostheses1-3). These substances are mostly expelled by ciliary movement in respiratory organs or via phagocytosis by macrophages. However, a small proportion of the dust may remain in the lungs and induce pulmonary damage. The morbidity rate for lung diseases in dental care workers seems to be higher than that for workers in other fields.

This paper describes a former dental technician who died of lung cancer associated with metastasis to the brain. At autopsy, assay for metal deposits in the lungs, liver, and kidneys was conducted, in addition to histopathologic examination. The risk of lung diseases among dental health care workers is also discussed.

Methods

Histopathologic examination

Organs obtained from a patient with lung cancer (case 1) were examined histopathologically and compared with those from a control patient with liver cancer (case 2).

Assay for metal deposits

From each of the upper and lower lobes of the left lung, the upper, middle, and lower lobes of the right lung, the central part of the liver, and the cortices and medullae of the kidneys, a 1-cm³ block of tissue was excised and lyophilized. The intensity of X-rays emitted from Ti, Cr, Mn, Fe, Ni, Cu, Zn, Se, Br, and Sr in each block was then measured by the particle-induced X-ray emission (PIXE) method4). A similar metal assay was conducted on case 2 and the data were compared with those for case 1.

Case

Case 1 An 84-year-old man, died of respiratory failure on November 27, 1990. He had worked as a dental technician until the age of 75 years. The chief lesion was lung cancer, which had arisen in the lower lobe of the right lung and metastasized to the brain (Fig. 1), liver, and lymph nodes. Histopathologically, the cancer was poorly differentiated adenocarcinoma (Fig. 2, a and b). Other lesions included bronchodilatation, pulmonary fibrosis, and suppurative pneumonia in the
Results

Assay for metals

In the upper lobe of the left lung, Cu and Zn deposits were greater in case 1 than in case 2, and Se deposits were smaller in case 1. Cr and Ni were present in case 1 only. Mn was not evident in either case. In the lower lobe of the left lung, Zn deposits were greater in case 1 than in case 2, but Fe and Br deposits were smaller in case 1. Cr and Mn were present in case 1 only. Ni was not detected in either case. In the upper and middle lobes of the right lung in case 1, Fe and Zn deposits were higher than in case 2; Ti and Cr were present in case 1 only. Ni was not evident in either case. In the lower lobe of the right lung with cancer, Ti and Zn deposits were greater in case 1 than in case 2, while Se and Br deposits were smaller in case 1. Ti and Cr were present in case 1.
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$x :$ case 1/case 2 (%)

-2: $x < 50$
-1: $50 \leq x < 90$
$\pm 0: 90 \leq x < 110$

Discussion

On the other hand, in the liver, Fe, Zn, Se, and Br deposits were greater in case 1 than in case 2, and Ti was present in case 1 only. Cr, Mn, and Sr were detectable in case 2 only; Ni was not evident in either case. In the cortex and medulla of the kidney of case 1, Fe, Cu, Zn, and Se deposits were greater than in case 2. Mn was present in case 1 only, and Sr was detected in case 2 only (Table 1).

In the lungs of case 1 as compared with case 2, Ti, Cr, Mn, Ni, and Zn were found in greater amounts. These elements are essential for dental materials, while other elements for the same use include Na, N, Al, Si, Ca, V, Fe, Co, Cu, Zn, Mo, Pd, Ag, Cd, In, Sn, Pt, Au, Hg, Pb, and Bi. Ti, Cr, Ni, and Co are used in Ti-Al-V, Co-Cr, Mo, or Fe-Ni-Co alloy. The increased amount of metals in the lungs in case 1 is thus attributed to inhalation of metal dusts derived from dental materials. Cr and Ni have drawn general attention as pathogenic elements. Elevated risks of lung and bronchial cancer have been observed among stainless steel factory workers, foundry workers, and among chromium plating workers. Cr can induce skin ulceration and perforation of the nasal septum. Hexavalent chromium in particular is more irritating and erosive than trivalent chromium, and is also known to be responsible for high incidences of chronic pneumonia and lung cancer. Kollmeier reported that three of four cases of bronchial carcinoma from 25 random autopsies showed high Cr and Ni values, and one of these was from a dental laboratory technician. However, it has recently been reported that Cr, other than hexavalent chromium, is not always responsible for carcinogenesis.

The biological half-lives (systemic) of Ti, Cr, Ni, Zn, and Cu are 320, 616, 667, 933, and 80 days, respectively. Given that considerable amounts of these metals remained in the lungs of the former dental technician, we examined this 10 years after retirement; it is considered that the patient may have inhaled larger amounts of metals than usual while in dental service, or that the inhaled metals were poorly extracted from the lungs. In the present study, Cr and Ni deposits in organs other than the lungs were not greater in case 1 than in case 2.
Our results may suggest that a cause and effect relationship exists between the onset of lung cancer and heavy metal deposits in the lungs. Therefore, it might be urged that environmental standards be improved in dental clinics and laboratories.

Acknowledgments

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References