Tumor risk from low-dose radiation exposures with the example of dental diagnostic X-ray

It was reported that exposure to dental diagnostic X-rays in oral, dental and maxillofacial care increases the risk of benign tumors (meningioma), but not of malignant brain tumors (glioma). Malignant gliomas grow more rapidly. Meningioma, a benign tumor, grows slowly; it may persist for many years without symptoms, or produce mild transitory pains, for example, along the trigeminal nerve branches (trigeminalgia), which may be perceived by the patient as originating from teeth, provoking him or her to go to the dentist and to undergo dental diagnostic X-rays. Besides, meningioma can cause seizures sometimes preceding other symptoms. Such patients may undergo diagnostic X-rays within the scope of examination for epilepsy and to go more frequently to a dentist because of injuries to teeth or oral mucosa due to seizures. Therefore, the reported association between dental diagnostic X-rays and meningioma can be explained by more frequent visits to dentists. Slow non-infiltrative growth of a benign tumor over many years is an argument against the cause-effect relationship between radiation and meningioma because X-rays with a higher probability would be performed when the tumor had already existed.

A carcinogenic effect has never been proven for the dose levels associated with diagnostic X-rays including the cone beam computed tomography (CBCT) applied in dentistry. The concept of carcinogenicity of low doses is based on the linear no-threshold (LNT) hypothesis postulating that linear dose-effect correlations, proven to some extent for higher doses, can be extrapolated down to minimal doses. However, there is an argument against the LNT hypothesis: living organisms have probably been adapted to background levels of ionizing radiation analogously to other environmental factors: various substances and chemical elements, products of radiolysis of water, visible and ultraviolet light, different kinds of stress, etc. Natural selection is a slow process; therefore, evolutionary adaptation to a changing environmental factor would correspond to some average from the past. Natural background radiation has probably been decreasing during the time of life existence on the Earth. DNA repair is an ancient mechanism, so that contemporary living organisms have probably preserved some capability to repair DNA damage from higher radiation levels than today’s natural background. According to the hypothesis of evolutionary adaptation to the natural radiation background, with the dose rate tending to the background level, radiation-related risks would tend to zero, and can even fall below zero within some dose range in accordance with radiation hormesis confirmed by some experiments. Admittedly, a part of experimental data does not agree with results of epidemiological studies. However, epidemiological studies of low-dose radiation effects in humans may be prone to biases, for example, self-selection, that is, more frequent self-reporting of patients knowing their higher doses. Cancer patients would probably recollect all facts related to the exposure averagely better than healthy controls (a phenomenon known as recall bias), especially if they know about potential carcinogenicity of radiation. Therefore, doses received by some cancer patients may be retrospectively overestimated compared to controls. Biases and limitations of epidemiological studies on low-dose exposures included a priori classification of spontaneous diseases as radiation-induced, discussion

of doses disregarding natural radiation background, conclusions about incidence increase of diseases without adequate comparisons with a control, etc. Admittedly, the concept of radioactivity as an environmental factor with an optimal exposure level remains largely in the theory needing more evidence from independent large-scale experimental studies. The most important conclusion is that protection from ionizing radiation is as important as the diagnostic benefit from X-rays, among other things, because radiation exposures are unpredictable during the human life, and their effects can accumulate.

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