Study Findings

Based on a follow-up study of atomic-bomb survivors over a period of 56 years since the time of radiation exposure to assessment of effects, we identified 104 cases of primary and malignant soft-tissue sarcomas with a mean colon dose of 0.18 gray (Gy). We found that the atomic-bomb radiation was associated with the development of these sarcomas. A linear dose-response in soft-tissue sarcomas was identified, with exposure to 1 Gy of radiation considered to double the risk of their development. The investigators further noted that the five-year survival rate for these subjects was 39%, which is lower than the rate generally reported in the literature.

Explanation

Soft-tissue sarcomas comprise approximately 1% of all cancer cases. They can occur anywhere in the body, severely affect function, decrease quality of life, often be difficult to clinically manage, and frequently lead to death. Numerous risk factors are implicated in the development of these sarcomas, and past studies have shown high levels of ionizing radiation exposure greater than 9 Gy to be strongly associated. Moreover, radiation-induced soft-tissue sarcomas have poor prognostic outcomes.

Dr. Dino Samartzis and researchers at RERF (Department of Epidemiology, Department of Statistics) assessed 80,180 Hiroshima and Nagasaki atomic-bomb survivors who were participants in the Life Span Study (LSS) to determine whether the atomic-bomb radiation would lead to the development of soft-tissue sarcomas. Findings from this study were published in the Journal of Bone & Joint Surgery (American Volume).

1. Purpose of the study

A prospective, longitudinal study was performed to assess the role of atomic-bomb radiation ranging from 0 to approximately 3 Gy in the development of soft-tissue sarcomas in the LSS cohort. As a secondary objective, the survival rate among the subjects diagnosed with soft-tissue sarcomas was also assessed.

2. Materials and methods

Based on the LSS cohort of Japanese atomic-bomb survivors, 80,180 individuals were prospectively assessed for the development of primary soft-tissue sarcomas. Colon dose in Gy and the excess relative risk (ERR) and excess absolute rate (EAR) per Gy of absorbed ionizing radiation were assessed. Subject demographic and age-specific factors related to risk, as well as factors related to survival, were evaluated.

3. Results of the study

(1) Association between ionizing radiation exposure (0 to approximately 3 Gy) and the development of soft-tissue sarcomas

A total of 104 soft-tissue sarcoma cases were identified (mean colon dose = 0.18 Gy). Mean ages at the time of bombing and sarcoma diagnosis were 26.8 and 63.6 years, respectively. A linear dose-response model with an ERR of 1.01 per Gy (95% confidence interval [CI]: 0.13 to 2.46, p = 0.019) and an EAR of 4.3 per Gy per 100,000 persons per year (95% CI: 1.1 to 8.9, p = 0.001) were noted in the development of soft-tissue sarcomas.

The ERR model demonstrated significant radiation-effect modification by attained age (log-linear effect modifier parameter –3.7, 95% CI: –6.4 to –0.8, p = 0.017), but not the EAR
model. Neither gender nor age at exposure significantly modified the ERR marginally, even after accounting for modification by attained age, nor did either factor modify the attained-age-constant EAR. The log-linear parameter for log age in the unmodified EAR model was 3.4 (95% CI: 2.30 to 4.70), consistent with the attained-age modifier of the ERR (–3.7).

(2) Survival rate of individuals diagnosed with soft-tissue sarcomas

Based on the latest LSS assessment of soft-tissue sarcoma cases, 23 individuals were confirmed to be alive (21.1%). Metastases occurred in 46 individuals (44.2%) at last follow-up. The mean survival period after diagnosis was 7.1 years (± standard deviation [SD]: 9.1 years; range: 0–44 years). The five-year survival rate was 39%, which did not statistically differ with gender, age at diagnosis, or sarcoma site of origin or histology. Regression analysis did not note such factors to be significantly predictive in this population. However, individuals who developed metastases had a statistically significant shorter survival period (mean: 3.0; ±SD: 4.0 years; range: 0 to 21 years) than those without metastases (mean: 9.5; ±SD: 8.7 years; range: 0 to 31 years) at last assessment (p < 0.001). The five-year survival rates for individuals who developed metastases and those who did not were 17.4% and 53.4%, respectively. Effects of treatment type on survival could not be discerned from this study.

Due to the poor prognostic outcomes associated with soft-tissue sarcomas, our study findings further stress the need to identify risk factors, such as ionizing radiation exposure, to prevent the occurrence of such lesions. Although the incidence of soft-tissue sarcomas in the general population is quite rare and various factors may contribute to their development, our study attempts to raise awareness that even moderate levels of ionizing radiation, from medical imaging, radiation therapy, and environmental exposure, can lead to the development of soft-tissue sarcomas.

The Radiation Effects Research Foundation has studied A-bomb survivors in Hiroshima and Nagasaki for more than 60 years. RERF’s research achievements are considered the principal scientific basis for radiation risk assessment by the United Nations Scientific Committee on the Effects of Atomic Radiation (UNSCEAR) and for recommendations regarding radiation protection standards by the International Commission on Radiological Protection (ICRP).

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