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1017 Bone Sarcomas in Atomic Bomb Survivors of Hiroshima & Nagasaki

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Purpose/Objective(s): Ionizing radiation-induced bone sarcomas have traditionally been associated with exposure to high levels of ionizing radiation. The role of exposure to lower levels of ionizing radiation in the development of such lesions remains speculative. Also, the appropriate dose-response model of radiation dose exposure to excess relative risk (ERR) in association with bone sarcomas is questionable.
Materials/Methods: The data source of the longitudinal, population-based Life Span Study (N=120,321) cohort of atomic bomb survivors of Hiroshima and Nagasaki was utilized to estimate the ERR per Gray (Gy) of ionizing radiation exposure in the development of bone sarcomas. Other factors regarding sarcoma demographics, age at time of exposure, time to diagnosis from exposure, survival, and additional clinical information were assessed. The follow-up period of the study was from January 1, 1958 to December 31, 2001. Bone marrow dose in Gy units was utilized.
Results: Following review, 80,181 participants met the inclusion criteria with a total of 2,170,679 person-years at risk. Nineteen bone sarcomas were identified with an incidence rate of 0.9 per 100,000 person-years. There were 11 males (58%) and 8 females (42%). The mean age at the time of the bombings was 32.4 years. Six participants (32%) were younger than 16 years of age at the time of the bombings. The mean age of sarcoma diagnosis was 61.6 years. The mean time to sarcoma diagnosis since exposure was 29.3 years. The mean bone marrow dose was 0.433 Gy. The most common sarcoma was classified as a malignant neoplasm with no further specification (42%), followed by osteosarcomas (26%). The most common cancer sites were bones of the pelvis, sacrum, and coccyx as well as associated joints (47%). The mean survival time after diagnosis was 2.5 years. Two participants were noted to be alive at final follow-up. The overall five-year survival rate unadjusted for treatment-type was 25% (males, 45%; females, 0%). No association between radiation exposure to the time of diagnosis, morphology, or topography of the bone sarcoma could be discerned from this study. A linear model with a threshold at 0.85 Gy (95% CI: 0.12-1.85) was found with an ERR of 1.1 at 1 Gy (8.7 at 2 Gy) (p=0.002).
Conclusions: In contrast to the reported literature, our study suggests that the development of radiation-induced bone sarcomas may be associated with exposure to much lower doses of ionizing radiation following a single whole body dose. A linear model with a threshold at 0.85 Gy was found to be the best predictive non-hormetic model with a statistically significant ERR of 1.1 at 1 Gy (ERR=8.7 at 2 Gy). Due to the small sample size, the affects of age at the time of exposure and radiation dose could not be properly discerned with regards to bone sarcoma development. A poor clinical prognosis was associated with bone sarcomas.

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