Effects of Prenatal Irradiation with an Accelerated Heavy-Ion Beam on Postnatal Development in Rats: II. LET-Related Neurophysiologic Alterations

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Effects on postnatal neurophysiological development in offspring were studied following exposure of pregnant Wistar rats to accelerated neon-ion beams with a LET value of about 30 keV/μm at a dose range from 0.1 Gy to 2.0Gy on the 15th day of gestation. The age at which four physiologic markers appeared and five reflexes were acquired was examined prior to weaning. Gain in body weight was monitored until the offspring were 3 months old. Male offspring were evaluated as young adults using two behavioral tests. The effects of X-rays at 200 kVp measured for the same biological end points were studied for comparison. Our previous study on carbon-ion beams with a LET value of about 13 keV/μm was also cited to elucidate a possible LET-related effect. For most of the endpoints at early age, significant alteration was even observed in offspring prenatally received 0.1 Gy of accelerated neon ions, while neither X rays nor carbon-ions under the same dose resulted in such a significant alteration compared to that from the sham-irradiated dams. All offspring whose mothers received 2.0 Gy died prior to weaning. Offspring from dams irradiated with accelerated neon ions generally showed higher incidences of prenatal death and preweaning mortality, markedly delayed accomplishment in their physiological markers and reflexes, and gain in body weight compared to those exposed to X-rays or carbon ions at doses of 0.1 to 1.5 Gy. Significantly reduced ratios of main organ weight to body weight at postnatal ages of 30, 60 and 90 days were also observed within this dose range. The results indicated that irradiation with neon ions at 0.1 to 1.5 Gy on day 15 of gestation caused permanent growth alterations in offspring that were dependent on dose. The alterations include permanent growth retardation, morphological malformations in main organs, i.e., microcephaly, diminished reflex attainment, delayed appearance of physiologic markers, and changes in adult behavior. Such exposure to 0.5 to 1.5 Gy of neon ions resulted in growth retardation and behavioral alterations that persisted throughout the period of study. Accelerated neon ions generally induced more detrimental effects than carbon ions and X rays,

indicating that prenatal radiation resulted in LET-related detrimental effects on postnatal development in rats.