A large number of patients with primary or metastatic tumors in the brain will require large volume or whole brain irradiation every year in the world, and in at least some of these patients, there is a strong likelihood of developing radiation brain injury including cognitive decline.

The low linear energy transfer (LET) irradiation-induced brain injury had been investigated well for many years. The injury can involve multiple regions and cell/tissue types, and a large number of physical and biologic factors impact the expression and extent of damage. Some clinical studies reported that the cranial irradiation could lead to the cerebral ischemia and increased the risk of stroke and transient ischemic attack in 5-year survivors which might play an important role in radiation-induced dementia.

Heavy-ion therapy, as the next generation of radiation therapy for cancer, possesses several advantages over conventional radiation therapy, which has been performed in several countries in the world. Many patients with skull base tumors and head-and-neck cancers had been irradiated with heavy-ions. It has been proved that the high LET rays $^{12}$C and $^{56}$Fe ions) irradiation caused the apoptosis of neurons and the loss of neural precursor cells in the hippocampal dentate gyrus.

As the “power house” of cells, mitochondria play the essential role in keeping the energy stabilization in normal brain tissue. The altered mitochondrial energy metabolism contributes to the pathophysiology of acute brain injury caused by ischemia, trauma, and neurotoxins and by chronic neurodegenerative disorders. Mitochondrial DNA (mtDNA) is a vulnerable target of irradiation including heavy ions. The irradiation could induce the mutation and deletion of mitochondrial genome, which would lead to the mitochondrial dysfunction. The objective of this study is to investigate the differences in brain mtDNA injuries induced by low LET (X-ray) or high LET (carbon ions).

In this study, we compared the mtDNA injury degree induced by carbon ions and X-ray irradiation. The long PCR result indicated that the carbon ions radiation induced serious damage in mice brain mtDNA till 72 h post-irradiation. X-rays irradiation also induced serious damage in mice brain mtDNA at 3 h post-irradiation. But the damage was repaired mostly since 8 h post-irradiation. The results indicated that the carbon ions caused the more serious injury and hard to repair in mouse brain mtDNA.

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