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3 - 75 4D Imaging with a Siemens CT using a Respiration Monitoring System

He Pengbo and Li Qiang

Modern radiotherapy aims to concentrate the dose to a tumor and to spare the normal tissue around as much as possible. However, organ motion poses a severe obstacle and leads to increased safety margins around the clinical target volume, hence increasing the volume of the irradiated normal tissue. A well-known example is the treatment of lung tumors, which may show respiratory motion of up to several centimeters. Adaptive radiotherapy techniques attempt to compensate such organ motion e. g. by gating on a predefined breathing phase or by tracking the tumor with the therapeutic beam. To simulate the delivered dose distribution in treatment planning, both techniques require time-resolved computed tomography (CT) images, known as four dimensional CT (4D-CT). 4D-CTs are generated by scanning the patient while acquiring a surrogate signal of the tumor motion. The acquired projections are sorted according to this signal. Several 3D-CT datesets are reconstructed depending on local clinical protocols.

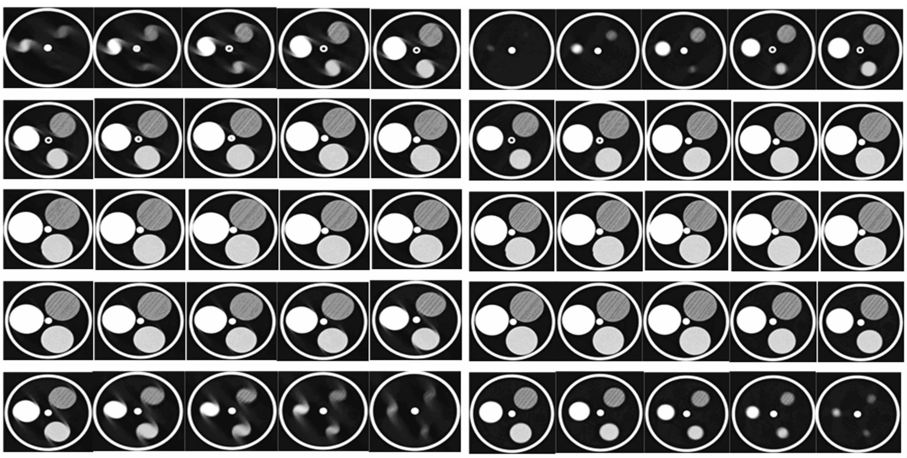

Fig. 1 Axial slices of the moving phantom. Window level 1200 centred at −600. 1.5 mm slice, 1.5 mm reconstruction increment, 50% exhalation (left) and 0% exhalation (right).

Using a moving phantom, a belt with an integrated pressure sensor (AZ-733V, Anzai) was simultaneously operated to provide a signal related to the motion of the phantom, where the signal got stronger with inhalation and weaker with exhalation. The wave deck received the signal from the sensor port and converted it to a digital signal to be sent to the host computer of the CT system. The signal was displayed real-time in the CT console, and the breathing information was stored at the reconstruction PC together with the raw data of the CT-acquisition. Image reconstruction was done with a local amplitude-based sorting algorithm, for which the breathing signals were divided into inspiration and exhalation parts. The acquired projections in this work were reconstructed with five different amplitude percentages such as 0, 20, 50, 80 and 100% of the exhalation phase.

Artifacts were still observed in gated scans with 20, 50 and 80% of the exhalation phase while almost no artifacts appeared with 0 and 100% exhalation. Fig. 1 shows 50% exhalation reconstruction of the phantom moving orthogonally to the scan plane (amplitude 2 cm, period 4 s), where the images had a window level of 1200 centred at -600 and the reconstruction thickness was 1.5 mm. The poles of the spheres appeared distorted with spiral-like artifacts. As the tube rotated, motion in and out of the imaging plane occurred. The cross section of the phantom in the beam varied. At the poles of the sphere there was a greater change in the axial cross-section radius of the sphere over one rotation resulting in a more pronounced change in density. While the moving phantom stayed in a quasi-static state at 0 and 100% exhalation, the artifacts were not obvious. We also accurately obtained the center position of the moving target for different motion states by 4D-CT. They were 59, 56, 51.5, 45.5 and 39.5 mm, corresponding to 0, 20, 50, 80 and 100% exhalation, respectively.

Residual motion artifacts were seen in gated scans when the object was moving in the scan plane. These artifacts were caused by the object's movement within the imaging plane during the tube rotation. Large deviations are seen at the poles of the sphere due to the greater change in the axial cross-section radius of the sphere over one rotation at this location. Even so, we could still determine the center position of the moving target accurately according to the 4D-CT method.

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3 - 76 Effect of Carbon Ion Irradiation on Mouse Motor Function

Ye Fei, Li Qiang, Liu Xiongxiong and Zhao Ting

Lots of reports showed that motor coordination and stamina of mice are impaired by heavy ion radiation due to injury of nerve center system (CNS). However, the conclusion in the aforementioned reports where whole body irradiation was used might be problematic. Damages of heavy ions to the peripheral nerve may lead to the same result like whole body irradiation.

In this study the head of Blab/c mouse, mesencephalon specifically, was exposed to carbon ions of 5 Gy. To avoid affect the peripheral nerve of mouse head, a special collimator was developed. In order to explore the short-latency effect of exposure to high energy particle radiation (HZE) on motor coordination and stamina, Gait and rotarod tests were employed. Twelve female Blab/c mice and twelve genetically matched wild-type (WT) mice were used in this study. Gait test provides a powerful measure of the precision and coordination of walking by the degree to which the forepaw and hind paw prints overlap. The mouse's paws were dipped in ink (forepaw red and hind paw black) so that the walking gait can be recorded as a track of footprints on the paper. Rotarod provides a simple automated test of an animal's ability for motor coordination and balance on a rotating rob, where the speed of rotation was 20 r/m. Fig. 1 shows that Footprint pattern of a mouse one week after irradiation with carbon ions (30 keV/(m, 5 Gy).

Fig. 1 Footprint pattern.

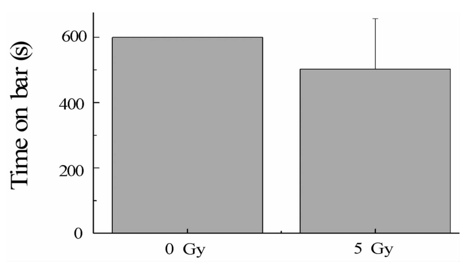

Fig. 2 Time for mice to stay on rotating robs.

Our experimental data reveal that motor coordination and stamina of mice in a short time after carbon ion irradiation remain intact. Together with whole body irradiation reports, these results imply that a decrease in motor coordination and stamina performance induced by heavy ions may result from injuries of epencephala or peripheral nerve system.