



Gunma University – Heavy-Ion Radiotherapy

# Exploring new frontiers in heavy-ion radiotherapy

**A pioneer of carbon-beam radiotherapy, Gunma University continues to lead the clinical application of heavy-ion beams through the highly successful Gunma University Heavy Ion Medical Research Center and the new Gunma University Initiative for Advanced Research.**

Heavy-ion radiotherapy is a next-generation medical technology that in just a few years has radically transformed the face of cancer treatment. This technique can target and destroy inoperable tumours with three-dimensional submillimetre accuracy in just a few short sessions, without radiation damage to surrounding healthy tissue. For brain cancers and other complicated tumours, heavy-ion therapy is now an effective medical option that promises cancer patients a vastly improved quality of life.

Gunma University, in collaboration with the National Institute of Radiological Sciences, was one of the first to adapt a heavy-ion particle accelerator for use in a clinical environment, and since it commenced operation in 2010, the Gunma University Heavy Ion Medical Research Center (GHMC) has remarkably increased the survival rates of patients with inoperable or complicated cancers. The facility is still one of only two in the world attached to a university hospital, which greatly enhances the cross-disciplinary academic and clinical research and development of carbon beam therapy.

Having demonstrated the medical

efficacy of heavy-ion therapy for cancer treatment in a clinical setting, the university is now turning its sights to further advancing the technology and expanding its range of applications, including microsurgery and even biomedical imaging.

“Last year, we established the Gunma University Initiative for Advanced Research to progress the heavy-ion beam technology further,” says Takashi Nakano, previously centre director and now professor and chairman of the Department of Radiology and Radiation Oncology. “The first goal of the initiative is to develop what we call ‘integrated oncology research’, which combines our core expertise in heavy-ion therapy with our strengths in endocrinology, metabolism and signalling research.”

Nakano’s team is also undertaking fundamental research on the biological basis for the high clinical antitumour effectiveness of carbon-beam therapy. “Using the latest super-resolution microscopy techniques, we have identified the mechanism of high cancer cell lethality, which will help us fine-tune various parameters of the technique,” Nakano explains. “We have also been investigating the relationship between carbon ion sensitivity and cancer-related gene abnormalities, which we also expect to feed back into improved therapies.”

By introducing a rapid dose-shaping fabrication system and modifying the ion beam extraction method to a more advanced radiofrequency knockout configuration, GHMC researchers have significantly shortened the waiting time for treatment,



Professor Takashi Nakano, chairman of the Department of Radiology and Radiation Oncology, School of Medicine, Gunma University.

sharpened the ion energy distribution and cut the treatment time itself. The ultra-sharp three-dimensional dose shapes now achievable make the carbon beam not only more effective for precision tumour treatment in difficult cases, but also suitable for use as a precise tool for microsurgery. “We now have a microsurgery-ready beamline, which will open many new opportunities for treatment,” says Nakano.



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