12-3 Contribution to Leading-Edge Medical Technology

— Development of a Supporting System for Boron Neutron Capture Therapy —

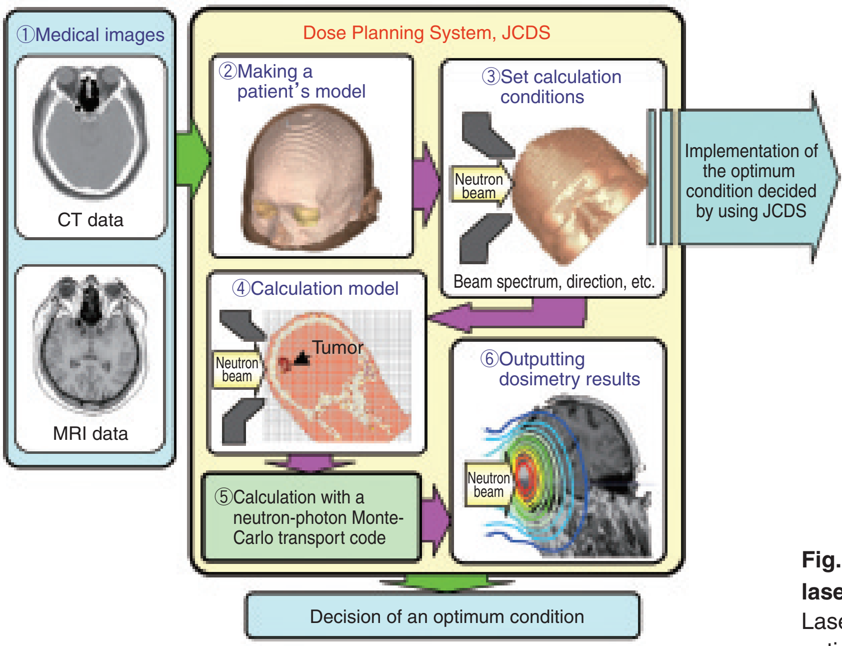

Fig.12-5 The Process flow of dosimetry by JCDS
JCDS creates a patient's 3D model using patient's medical images. Doses are determined by calculation with Monte-Carlo transport code. Optimum conditions for irradiation are identified based on the calculation results.

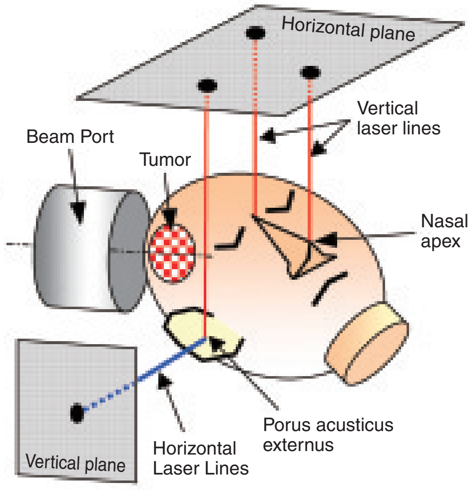

Fig.12-6 Patient immobilization method using laser beams
Laser beams are directed at where points on the patient's face such as nasal apex, eyes, and ears should be. By aligning the actual patient's head with these beams, it is fixed accurately to the irradiation position.

Boron neutron capture therapy (BNCT) is a sort radiation therapy for an obstinate cancer like a malignant brain tumor. In the BNCT procedure, doctors first inject a boron compound that builds up selectively in the cancer cells of a patient, and subsequently the patient is irradiated by a neutron beam. Alpha particles and lithium atoms, which are generated by interaction between neutrons and boron-10 atoms in the cells, destroy the cancer cells. Now it is expected that a malignant tumor located in the deeper part of the brain can be also treated by using an epithermal neutron beam.

The supporting system consisting of a dose planning code and a patient immobilization device was developed to perform the BNCT irradiation with high accuracy. The former, called the JAEA Computational Dosimetry System (JCDS), can estimate doses around the diseased part precisely. JCDS employs the Monte-Carlo transport method to determine doses based on patient's medical images. Fig.12-5 shows the process flow of dosimetry by JCDS.

The development of JCDS enables determination of the optimum conditions for irradiation. Next, in the actual BNCT, the implementation of irradiation according to these conditions is required. In particular, the patient's position greatly affects the accuracy of the irradiation. Thus, the patient setting system, which can immobilize the patient to the precise irradiation position by using laser beams, was developed. Fig.12-6 shows the positioning method using laser lines.

To improve the irradiation accuracy, JCDS and the patient setting system were integrated in one support system. Technologies which can support BNCT comprehensively including treatment planning, patient's positioning and retrospective evaluation of an irradiation have been established.

These support technologies have been developed for practical use, and BNCT clinical trials with epithermal neutron beam have been performed at Japan Research Reactor No.4 (JRR-4) since 2003. Clinical trials for head-&-neck cancer and lung tumor began in 2004.

Technological development to apply reactor functions to the medical field is continuing, and thus support is being given to advanced medical research aimed at overcoming intractable cancers.

Reference

Kumada, H. et al., Verification of the Computational Dosimetry System in JAERI for Boron Neutron Capture Therapy, Physics in Medicine and Biology, vol.49, 2004, p.3353-3365.