Development of new bolus for BNCT by C-BENS

-Irradiation test of 3D printed foot phantom-

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[Introduction]

In recent years, neutron sources for BNCT is transitioning from reactor-based to accelerator-based. Accelerator-based neutron sources produce mainly epithermal neutrons, which have higher energy than thermal neutrons, to treat deep-seated tumors. However, when treating superficially located tumors, such as melanoma and angiosarcoma, the thermal neutron flux at these regions are low because epithermal neutrons are not thermalized sufficiently, resulting in low dose to these resgions. In this research, a new type of bolus designed for the treatment of melanoma using Cyclotron based epithermal neutron source (C-BENS) has been developed and an irradiation test using a 3D printed foot phantom was carried out.

[Materials and Methods]

Hydrogel material was used for bolus development. The foot phantom was made from 3D scan data and the inside of the phantom was filled with water. The bolus (150mm square, thickness 20mm) was affixed to the surface of the foot phantom. The thermal neutron flux distribution at the phantom surface was measured using gold activation method. Gold wires and foils with and without cadmium cover were placed on the phantom surface. The phantom was irradiated using the C-BENS with a 12 cm diameter field size. After the irradiation, the thermal neutron flux distribution was derived from measuring the activation amount of the gold wires and foils.

[Results]

The thermal neutron intensity at the center of irradiation field was 8.5×10^8 n/cm^2/s. On the irradiation test of the cubic water phantom, the thermal neutron intensity at the center of irradiation field at the phantom surface was 4.0×10^8 n/cm^2/s. This showed that the bolus enhanced the thermal neutron intensity at the phantom surface by approximately 2 times.

[Conclusion]

A new type of bolus made from hydrogel, designed for BNCT using C-BENS has been developed and an irradiation test assuming the treatment for melanoma using a 3D printed foot phantom was carried out. It was confirmed that the bolus with a thickness of 20 mm enhanced the thermal neutron intensity at the phantom surface of the center of irradiation field by approximately 2 times. This showed that this bolus has the ability to increase the boron dose component. Therefore, it can be expected to improve the therapeutic effect of BNCT by C-BENS to the superficially located tumors.

References

1. H. Tanaka, Y. Sakurai and M. Suzuki, et al., Experiment verification of beam characteristics for cyclotron-based epithermal neutron source (C-BENS)., Applied Radiation and Isotopes, 69, 1642-1645 (2011).
2. H. Tanaka, Y. Sakurai and M. Suzuki, et al., Characteristics comparison between a cyclotron-based neutron source and KUR-HWNIF for boron neutron capture therapy., Nuclear Inst. And Methods in Physics Research, B, 267, 1970-1977 (2009)
3. T. Seppälä, J. Collan, I. Auterinen, et al., A dosimetric study on the use of bolus materials for treatment of superficial tumors with BNCT, Applied Radiation and Isotopes, 61, 787-791(2004)