Evaluation of the therapeutic consequences of patient movement during BNCT treatment for the INFN RFQ epithermal neutron beam.

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The Italian National Institute of Nuclear Physics (INFN) has built a 5 MeV RFQ proton accelerator delivering a current of 30 mA. The target is in its final stage of development and it is made of beryllium. With these characteristics, the $^{9}Be(p,n)^{9}B$ reaction is capable of delivering 10^{14} neutrons per second, with a mean energy of approximately 1,5 MeV. From this neutron source an epithermal neutron beam was designed with MCNP6, optimizing the Beam Shaping Assembly (BSA) to deliver clinical treatments [I. Postuma to be published].

With the designed BSA, the neutron flux obtained allows treatment times of the order of one hour. Moreover, as in clinical BNCT performed in Finland [1], one treatment may be separated into two sessions, where the patient position is modified between one session and the other. In any case, the amount of time where the patient needs to stay still is quite long, and this may cause unwanted movements during the irradiation with a consequent influence in the dose distribution.

With this work we want to define a way to evaluate the importance of the movement of the patient for the epithermal neutron beam developed by INFN facility. The idea is to define a tolerance level, where the patient movement does not influence significatively the outcome of the treatment. To perform this task, it is necessary to use a quantity that defines the quality of the treatment. We decided to use the Uncomplicated Tumor Control Probability (UTCP) [L. Provenzano, this conference]. This provides a radiobiological figure of merit that condenses the 3D information of dose distribution into one scalar value related to the clinical performance of the treatment as follows: the highest value of the UTCP maximizes the probability of controlling the tumor without normal tissue complications.

The work was performed by transporting neutrons with MCNP6. We coupled the INFN RFQ neutron source and BSA to the cylindrical phantom developed by L. Provenzano et al, which is essential for the computation of UTCP. To simulate the patient movement effect, we displaced the phantom perpendicularly and along the beam axis with fixed steps. Results will be presented at the conference.

References

1. Kankaanranta, Leena, et al. "Boron neutron capture therapy in the treatment of locally recurred head and neck cancer." *International Journal of Radiation Oncology Biology Physics*69.2 (2007): 475-482.