Evaluation of Phantom Dose in a Rotating Total Skin Electron Irradiation (RTSEI) Using Monte Carlo Method and Optically Stimulated Luminescent Dosimeter (OSLD)

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Purpose:

The purpose is to study the optimal Rotating total skin electron irradiation (RTSEI) treatment method through phantom dose evaluation using Monte Carlo method and optically stimulated luminescent dosimeter (OSLD)

Materials and Methods:

RTSEI was administered using a Vital linear accelerator (Varian Medical Systems, Palo Alto, CA) which can be equipped with a 6-MeV HDTSEI plate at a dose rate of 1000 MU per minute. The human phantom and plates capable of various RPM controls were used. Using the same clinical conditions, SSD 364.5 cm, Field size 36×36 cm^2 which delivery 7770 MU per fraction. The RTSEI covered the upper and lower parts of the phantom body using a double angle field at the gantry angles of 73° and 107° as a result of the profile measurement. OSLD attaches to a total of 28 regions of interest (ROI), including 8 ROIs to umbilicus level of Phantom, 4 ROIs to breast level, and 3 ROIs of hip level, and then the phantom rotates at 2 rpm to deliver the dose. In addition, the human phantom was scanned with SIM-CT for Monte Carlo simulation, and the Monte Carlo simulation was performed under the same energy conditions as the OSLD Phantom study. OSLD results were used to verify Monte Carlo simulations, and the skin dose of Monte Carlo simulations was measured by matching the location of the OSLD using the Varian Eclipse application. The results of the Monte Carlo simulation were compared and analyzed after normalization with a prescription dose of 2 Gy.

Results:

The RTSEI Phantom study found that OSLD standard deviation at the umbilicus levels was 0.08 Gy, showing an even dose distribution compared to the standard deviation of 0.53 Gy for other ROIs. Similarly, the Monte Carlo simulation standard deviation at the umbilicus, breast and hip levels was 0.18 Gy with an even dose distribution compared to the standard deviation of 0.86 Gy of the other ROI. This shows more uniform doses than other levels at the umbilicus, breast and hip levels.

Normalization of OSLD and Monte Carlo simulations to average dose values for the umbilicus level resulted in both breast 97.3%, Hip levels 97.6% in OSLD, both breast 95.5%, hip levels 91.5% in Monte Carlo simulations. However, in the other ROI, neck 77.2%, anus 50.2%, both inguinal 38.4%, forearm(inside) 79.1% in OSLD, neck 50.5%, anus 48.7%, both inguinal 32.6%, forearm(inside) 67.7% of Monte Carlo simulation. This shows that low doses exist in other ROI than the umbilicus, breast and hip levels.

Conclusions:

The results of the RTSEI phantom studies using the Monte Carlo method and OSLD observed the same low dose ROI as similar dose distributions. In particular, we were able to observe distinct low-dose areas in the neck, anus, both inguinal, and forearm (internal) areas where the skin overlapped or covered. Clinical treatment using the RTSEI method is thought to require more research to maintain a patient's position without overlapping legs and arms to reduce areas where low doses occur.

Keywords:

Rotating Total Skin Electron Irradiation (RTSEI), Monte Carlo Method, Optically Stimulated Luminescent Dosimeter (OSLD).