

Purpose: To determine secondary cancer risk in paediatric patients treated with intensity modulated proton radiation therapy (IMPT) compared to IMRT.

Methods: Proton therapy plans were created for fifteen patients previously treated with photon beam IMRT. IMPT plans were planned using the Eclipse treatment planning system (Varian Medical Systems, Palo Alto, CA) with a scanned proton beam model. The proton plans were planned to the same prescription dose as the photon plans. Each proton plan consisted of one to three fields, depending on tumour location, and photon plan constraints were used as a guide for IMPT constraints. Proton and photon plans were compared for dose conformity, homogeneity, volumes of tissue receiving low doses, integral dose, and second cancer induction risk. Second cancer risk was determined using two methods. The relative risk of secondary cancer was found by applying a linear relationship between integral dose and relative risk of secondary cancer. The second approach used the organ equivalent dose concept to describe the dose in the body and then calculate the excess absolute risk (EAR) for solid cancers.

Results: IMPT and IMRT plans had similar target conformity, homogeneity, near minimum, near maximum and median doses however IMPT plans had reduced integral dose and volumes of the body receiving low dose. IMPT plans resulted in a 0.313 ± 0.098 smaller relative risk of secondary cancer than IMRT plans. The EAR of secondary cancer in the body 30 years after treatment was reduced by 20.89 ± 9.56 , 24.30 ± 8.46 and 22.91 ± 7.91 patients per 10000 patients per year for the linear, linear exponential and plateau dose-response models respectively in IMPT compared to IMRT plans.

Conclusions: Two methods were used to determine the risk of secondary cancers following radiation therapy in paediatric patients. Both methods indicated that IMPT results in a lower risk of secondary cancer than photon beam IMRT.