Comparison of Out-Of-Field Doses in pediatric patients from Craniospinal Irradiations using photon, proton and electron spinal fields

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Purpose

Radiation therapy is a significant therapy and has greatly increased the survival rate for pediatric patients suffering from medulloblastoma and Acute Lymphoblastic Leukemia (ALL). The survival rates of these patients dramatically increased after the introduction of Craniospinal Irradiation (CSI) technique. However, with this improvement is a new challenge has emerged – late secondary complications and malignancies, resulting from the leakage and scatter radiation. Children, because of their smaller bodies, greater radiosensitivity and early age are most vulnerable to such late complications. Moreover 70% of childhood cancer survivors are expected to experience late complications 30 years after diagnosis [1]. Rapid development in the treatment techniques and utilization of new treatment modalities, like heavy charged particles (protons) have greatly improved the dose distribution around the target and minimize the scattered radiation. However, passively scattered proton produce neutrons primarily in nuclear interactions within the tissue and the high-Z aperture. These scattered neutrons can potentially increase the peripheral dose over and beyond what is normally associated with the primary treatment modality such as x-ray and electron treatments.

The purpose of current study is to investigate and compare the out-of-field doses to a pediatric patient from three different modalities of CSI.

Methods and Materials /continued

This study was performed to determine the relative contributions of the points of interest. Because of the complicated arrangements of the CSI techniques, a clarification of the terms in Field (F) and Out of Field (OF) is necessary. A location is considered to be OF if 1.5 cm out of the volume, defined by the geometric boundary of the photon beams. If more than the respective POC box inside that volume but it is still out of the target. Out of Field doses correspond to all points that are outside the target.

Both, the electron and photon plans were delivered on a Varian 21EX linac at MDACC. Double loaded TLD-100 pellets were placed at each point of interest and each of the two conventional plans were delivered three times for better statistic resulting in total of six measurements for each treatment at a given point. The TLDs were read and analyzed at the Radiologic Physics Center (RPC) in Houston. Standards were prepared and irradiated in advance, according to the expected dose to each points of interest. For the purpose of determining the mean doses, we used – for TLDs that were expected to receive less than 5 Gy, between 5 and 15 Gy and above 15 Gy respectively. Out-of-field doses from the proton therapy plan were calculated using the MCNPX Monte Carlo code. The treatment plan (treatment unit) was planned, and the dose was converted to TLDs using the Monte Carlo simulation code. The treatment plan (treatment unit) was planned, and the dose was converted to TLDs using the Monte Carlo simulation code. The treatment plan (treatment unit) was planned, and the dose was converted to TLDs using the Monte Carlo simulation code.

Conclusion and references

Conclusion

Several studies have suggested that out of field doses are associated with late complications from radiation therapy and are an important consideration for both the clinician and patient. The comparison of the dose results from the photon and proton treatments showed that the dose from the proton treatment was significantly lower than those due to the electron treatment. Yet at three location the electron CSI plan out of field doses were significantly higher. One of these locations was the skin. The other two were in the anterior lung proximal to the beam axis.

References


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