Clinical risk of carcinogenesis from passively scattered proton beams

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Background

Neutron contamination from high Z materials in a passively scattered beam has been cause for concern regarding carcinogenesis because neutrons are quite potent in this regard.

Based on a combination of neutron dose measurements and theoretical calculations this risk has been shown to be as low or even lower than for photon irradiation techniques.

Methods/Materials

To evaluate the true risk to patients, long term clinical outcomes need to be analysed. We therefore studied a cohort of 322 patients for the occurrence of in field and out of field secondary malignancies (SMs), 260 of the 322 were treated for benign pathologies.

Follow up was achieved by way of medical records, telephone calls to patients, and home visits by social workers or community nurses. All patients with 24 or fewer months of follow up were excluded, as well as patients who had previous photon therapy.

Of the 322 patients, 164 were female and 158 were male. Ages ranged from 2–85 years, with a median of 40 years. 13% were <20 years, 27% were <30 years, and 69% were <50 years of age at the time of treatment. Their follow up ranged from 25 to 276 months, with a median of 150 months. The 41 patients under the age of 20 had a median follow-up of 15 years.

Rates of observed malignancies in the patient population were compared with expected rates, which were obtained from the national cancer statistics.

We analyzed the group as a whole, and also particular sub-populations, including patients who were treated for benign pathologies, and children who were treated with the proton therapy.

Results

A variety of 7 out of field SMs developed during the follow-up period, in keeping with observed rates in the general population based on the national cancer statistics. 8 patients developed intracranial meningiomas, all after treatment for benign conditions.

No in-field secondary malignancies were seen in patients treated with protons alone. However, a solitary patient treated with neutrons and a proton boost developed a poorly-differentiated carcinoma within the radiation field.

None of the 41 paediatric patients have developed a secondary malignancy after a median follow-up of 15 years

Conclusions

For out of field SM’s no increased risk of developing a malignancy was observed.

The infiel SM occurred in a patient who had been treated predominantly with neutrons so may not be attributable to proton treatment.

There was a small risk of developing a meningioma after treatment for acoustic neuroma or meningioma.