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Brain

Risk of cerebrovascular events among childhood and adolescent patients receiving cranial radiation therapy: A paediatric normal tissue effects in the clinic normal tissue outcomes comprehensive review.

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PURPOSE

Radiation-induced cerebrovascular toxicity is a well-documented sequelae that can be both life-altering and potentially fatal. We performed a meta-analysis of the relevant literature to create practical models for predicting the risk of cerebral vasculopathy after cranial irradiation.

METHODS AND MATERIALS

A literature search was performed for studies reporting paediatric radiation therapy (RT) associated cerebral vasculopathy. When available, we used individual patient RT doses delivered to the Circle of Willis (CW) or optic chiasm (as a surrogate), as reported or digitised from original publications, to formulate a dose-response. A logistic fit and a normal tissue complication probability (NTCP) model was developed to predict future risk of cerebrovascular toxicity and stroke, respectively. This NTCP risk was assessed as a function of prescribed dose.

RESULTS

The search identified 766 abstracts, five of which were used for modelling. We identified 101 of 3989 paediatric patients who experienced at least one cerebrovascular toxicity: transient ischemic attack, stroke, moyamoya, or arteriopathy. For a range of shorter follow-ups, as specified in the original publications (approximate attained ages of 17 years), our logistic fit model predicted the incidence of any cerebrovascular toxicity as a function of dose to the CW, or surrogate structure: 0.2% at 30 Gy, 1.3% at 45 Gy, and 4.4% at 54 Gy. At an attained age of 35 years, our NTCP model predicted a stroke incidence of 0.9% to 1.3%, 1.8% to 2.7%, and 2.8% to 4.1%, respectively at prescribed doses of 30 Gy, 45 Gy, and 54 Gy (compared with a baseline risk of 0.2%-0.3%). At an attained age of 45 years, the predicted incidence of stroke was 2.1% to 4.2%, 4.5% to 8.6%, and 6.7% to 13.0%, respectively at prescribed doses of 30 Gy, 45 Gy, and 54 Gy (compared with a baseline risk of 0.5%-1.0%).

CONCLUSIONS

Risk of cerebrovascular toxicity continues to increase with longer follow-up. NTCP stroke predictions are very sensitive to model variables (baseline stroke risk and proportional stroke hazard), both of which found in the literature may be systematically erring on minimization of true risk. We hope this information will assist practitioners in counselling, screening, surveilling, and facilitating risk reduction of RT-related cerebrovascular late effects in this highly sensitive population.