265

NUCLEAR FRAGMENTATION IN CLINICAL HEAVY ION BEAMS, SHOULD WE WORRY?

N. Bassler¹, A. Lühr¹, J. Toftegaard², D.C. Hansen³, R. Teiwes², N. Sobolevsky⁴, O. Jäkel⁵, R. Herrmann¹

¹Dept. of Experimental Clinical Oncology, Aarhus University, Denmark

²Dept. of Physics and Astronomy, Aarhus University, Denmark

³Dept. of Computer Science, Aarhus University, Denmark

⁴Inst. of Nuclear Research RAS, Moscow, Russia

⁵German Cancer Research Center, Heidelberg, Germany

Particle therapy with fast ions is increasingly applied as a treatment option for localized inoperable tumour sites. One of the reasons for the increased complications of understanding heavy ion dosimetry and radiobiology stems from the mixed particle spectrum which occurs due to nuclear fragmentation of the primary ions. Even if patient treatment with heavy ions has been established, the influence of nuclear fragmentation is yet to be fully quantified. The fragmentation spectrum of ions is relevant for particle therapy in numerous ways:

1) Dose distribution: A distinct tail of secondary particles is formed beyond the Bragg-peak. This tail may deliver unwanted dose to normal tissue, however the magnitude of the tail is directly depending on the inelastic nuclear reaction cross sections.

2) Dosimetry

a) Stopping power ratios: Routine dosimetry is performed with air-filled ionization chambers. However, the dose is by convention expressed in dose relative to water. The link between these different ways of calculating dose is primarily provided by stopping power ratios, i.e. atomic physics, however since the average stopping powers are weighted by fluence, one might expect a weak dependence on the secondary particle spectrum from fragmentation.

b) In addition hereto, fluence correction factors can be calculated which take this effect into account, which are directly a result of nuclear fragmentation in the medium.

3) Radiobiology: Physical dose is not sufficient to describe the outcome of a treatment. The concept of relative biological effectiveness (RBE) translates the physical dose to a biological effective dose which is iso-effective to photon radiation. Radiobiological models based on amorphous track structure such as the Local Effect Model, but also microdosimetry based models both rely on a full description of the mixed particle spectrum found in a point. To date only little has been published about how much the secondary particle spectrum influences the radiobiology. Other effects which have not been investigated by us include the impact on the occurrence of secondary cancer arising from the secondary neutron spectrum in surrounding tissue, and the production of secondary radiation for retrospective (or online) treatment plan verification. We change essential parameters in the underlying nuclear models of the Monte Carlo particle transport code SHIELD-HIT10A, in order to quantify the sensitivity on the three fields mentioned above, including: turning off nuclear fragmentation entirely, changing all inelastic cross sections $\pm 20\%$, changing key parameters in the

Fermi-Breakup (FB) model. Results show nuclear effects have their largest impact on the dose distribution. Stopping power ratios are entirely unaffected, fluence correction factors are merely in the order of 5% or less. Impact on the RBE is next to negligible, and is rather associated with the dependency of dose.

267

IMPACT OF TIMING OF CHEMOTHERAPY IN THE TREATMENT OF PATIENTS WITH OPERABLE RECTAL CANCER: PRELIMINARY RESULTS FROM A RANDOMIZED PHASE II STUDY

T. Vuong¹, T. Niazi², S. Devic², P. Kavan², E. Ferland³, G. Batist²

¹Jewish General Hospital

²McGill University, Jewish General Hospital DEVIC, Slobodan (McGill)

³Centre Hospitalier Pierre-Boucher, Longueuil, Quebec, Canada, J4M 2A5

Introduction: The introduction of neoadjuvant chemotherapy and radiation therapy in addition to total mesorectal excision (TME) achieved a major success in the treatment of patients with operable rectal cancer with respect to pelvic control. Nevertheless, it is now observed that such strategy may have a negative impact in the subsequent chemotherapy compliance. The present study is evaluating the impact of chemotherapy timing on patient compliance in selected patients with high risk for metastases.

Material and methods: At McGill University, High Dose Rate Endorectal Brachytherapy (HDREBT) has been successfully used as an effective tumor downstaging radiation modality in patients with operative rectal cancer for the last ten years. For the present study we were selecting operable patients with high risks for metastases established by magnetic resonant imaging (MRI) defined by positive nodes, involving circumferential margins (CRM) or extramural venous invasion (EMVI). Patients were randomized between two arms: 6 cycles of neoadjuvant FOLFOX chemotherapy followed by HDREBT (26 Gy in 4 fractions) prior to TME surgery and 6 cycles of adjuvant FOLFOX chemotherapy (Arm A), versus HDRBT (26 Gy / 4 fractions) then TME surgery followed by 12 cycles of FOLFOX chemotherapy (Arm B).

Results: After 20 months of study activation, 40 out of planned sample size of 240 patients from 3 institutions