

Theme: Physics

Abstract No.: PTCOG-AO2025-ABS-0099

The effect of survival fraction by tumor repopulation according to different treatment schedules at the Japanese carbon ion therapy center

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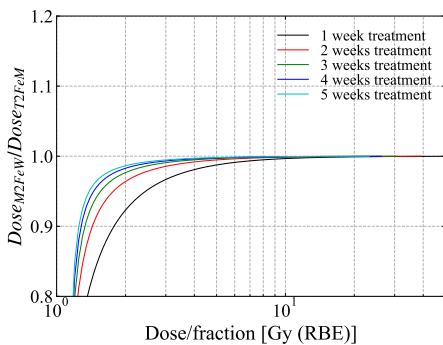
Background / Aims:

- To compare the effect of survival fraction (SF) and prescribed dose by tumor repopulation at the Japanese carbon ion therapy center with a treatment protocol of different treatment days between Tuesday, Wednesday, Thursday, and Friday (Tuesday to Friday except for Monday, T2FeM) and Monday, Tuesday, Thursday, and Friday (Monday to Friday except for Wednesday, M2FeW).

Subjects and Methods:

- For the linear-quadratic (LQ) model, $SF(d; \alpha, \beta)$ is calculated by $\exp(-\alpha d - \beta d^2)$
- SF for multiple fraction, n is calculated by $\exp(-\alpha d - \beta d^2)^n$
- Japanese relative biological effectiveness (RBE) model is based on the response in the human salivary gland (HSG) cell, so the response in X-ray for the HSG cell of $\alpha = 0.15 \text{ Gy}^{-1}$, $\beta = 0.0615 \text{ Gy}^{-2}$ was referenced (Furusawa et al 2000).
- The correction per fraction by repopulation was calculated as e^{T_i/T_g} , where T_i is the elapsed days since the last treatment, and T_g is a parameter describing the growth, which was used as 7.
- SF for multiple fraction considering repopulation is $\exp(-\alpha d - \beta d^2 + \frac{T_i}{T_g})^n$
- For each T2FeM and M2FeW treatment schedule, the SF considering the repopulation is calculated as, where w is total week during treatment course.
 - T2FeM: $\exp(-\alpha d - \beta d^2 + \frac{1}{T_g})^{3 \times w} \times \exp(-\alpha d - \beta d^2 + \frac{4}{T_g})^{w-1}$
 - M2FeW: $\exp(-\alpha d - \beta d^2 + \frac{1}{T_g})^{2 \times w} \times \exp(-\alpha d - \beta d^2 + \frac{2}{T_g})^w \times \exp(-\alpha d - \beta d^2 + \frac{3}{T_g})^{w-1}$
- Finally, Dose can be calculated as, $D = \frac{-\alpha + \sqrt{\alpha^2 - 4\beta SF}}{2\beta}$

Result:



- The difference in M2FeW for T2FeM was calculated according to the dose per fraction.
- The dose delivered by repopulation was slightly lower in M2FeW than in T2FeM. However, at current carbon therapy doses exceeding 4.3 Gy (RBE) per fraction, the effect on the delivered dose in both protocols appeared minimal.