SEMI-EMPIRICAL FORMULA FOR DETERMINING ABSORBED DOSE IN GdNCT STUDIES WITH MAGNEVIST

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Due to the complexity of neutron radiation dosimetry, it is convenient to determine the absorbed dose by determining kerma (K), a close analog of the absorbed dose. When the secondary charged particles are in equilibrium, the kerma will equal the absorbed dose. The advantage of kerma is the ability to determine it by calculating for a known monoenergetic neutron flux and the neutron spectrum. When calculating kerma, all processes that form the absorbed dose in biological tissues are considered. Using the values of the partial components of dose estimates in soft biological tissue, it is possible to calculate the value of the total absorbed dose depending on the concentration of natural Gd in the tissue. The total absorbed dose in biological tissue with a Gd-based drug is determined [1,2]:

$$D_{total} = D_n + D_\gamma + D_n^{ppmGd} + D_\gamma^{ppmGd} \tag{1}$$

This formula can be written in terms of kermas:

$$D_{total} = m \cdot t(K_{bt}^n + K_{bt}^{ph}) + \rho \cdot t(K_{1ppmGd}^n + K_{1ppm\,Gd}^{ph}) \tag{2}$$

where *m* is the mass of the irradiated tumors, *ρ* is the concentration of Gd in the tumor and *t* is the irradiation time. K_{bt}^n and K_{bt}^{ph} are calculated values of neutron and photon kerma power for biological tissue irradiated by a beam of epithermal neutrons from the WWR-SM reactor of the Academy of Sciences of the Republic of Uzbekistan. $K^n{}_{1ppmGd}$ and $K^{ph}{}_{ppmGd}$ are calculated values of neutron and photon kerma power for 1 ppm Gd in 1 g of biological tissue irradiated by the same beam.

We have conducted some studies to study the influence of existing effects on the formation of the absorbed dose during GdNCT [1,2]. The formula shows that the absorbed dose depends on gadolinium concentration in the tumor.

Therefore, the pharmacokinetics of the drug was studied [3]. As is known, patients undergo several tomographic studies with Gd contrast agents before radiation therapy. Since the absorbed dose during GdNCT strongly depends on the concentration of Gd in tumors, we studied the accumulation of Gd in human brain tumors [4]. It was found that intravenous injection of Magnevist left trace amounts of gadolinium in various concentrations in brain tumors.

These concentration values show its correlation with the number of tomographic studies performed. On the other hand, the cross-section (n, γ) of the reaction in Gd is of great importance, σ = 46,000 barns. Therefore, when neutron irradiation of tumors with the drug Magnevist, uneven irradiation is observed, associated with the effect of attenuation (self-shielding) of the beam in the tumor itself [3]. Taking into account the obtained results, the final semi-empirical formula for determining the absorbed dose can be written as:

$$D = \left[\left(m \cdot K_{bt}^n \right) + \left(m \cdot K_{bt}^{ph} \right) + \left(\rho_{Gd}(1-\delta) + \Delta\rho_{Gd} \right) K_{1ppmGd}^n + \left((\rho_{Gd}(1-\delta) + \Delta\rho_{Gd} \right) K_{1ppmGd}^{ph} \right] \cdot t \cdot s \tag{3}$$

where δ is the correction coefficient to take into account the pharmacokinetics of the drug with Gd, Δρ is the correction to take into account the accumulation of Gd, coefficient s is to take into account the self-shielding effect of Gd.

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