First Latin-American Congress
on Solid State Dosimetry and Radiation Measurements
13-17 September, 2021

EVALUATION OF THE IMPACT OF SHIELDINGS ON FETAL DOSE FOR THE TREATMENT OF BREAST CANCER USING MONTE CARLO SIMULATION

CATUSSO, L.[1], SANTOS, W.S.[2], SILVA, R.M.V.[3], VALENÇA, J.V.B [4].
[1]Pontifical Catholic University of Porto Alegre,90619-900, Porto Alegre, RS, Brazil, leonardo.catusso@edu.pucrs.br
[2]Federal University of Uberlândia (INFIS/UFU), 38408-100, Uberlândia, MG, Brazil
[3]Cancer Institute of Ceará, 90620-110, Fortaleza, CE, Brazil
[4]Federal University of Health Sciences of Porto Alegre (UFCSPA), 90050-170, Porto Alegre, RS, Brazil

Introduction: The radiation dose involved in radiotherapy (RT) procedures is high compared with other applications of ionizing radiation in medicine and biology. Pregnant women are susceptible to cancer development and the most common kind is breast cancer, with incidence from 1 to 3 in 10000 pregnancies [1].

Pregnant women with cancer diagnosis can be submitted to RT, depending on some particularities such as the location of the disease [2]. The associated risk of the out-of-field dose is higher in these patients because of the significant radiosensitivity related to the fetus.

Monte Carlo simulation is a tool that enables the study of different scenarios involving radiation interaction processes, which includes the analysis of the dose deposited on the fetus, amniotic sac and placenta during a breast RT in a pregnant woman.

Material and method: The simulation code used in this work was MCNPX 2.7.0, with an anthropomorphic phantom (MARIA) of a pregnant woman with 24 weeks gestation. RT of the left breast was simulated.

The fetus model used in this work presents a development related to 24 weeks of gestation and during this period the threshold dose is 0.25 Gy for tissue reactions [3].

For this work, two 10x16 cm² fields were used: medial (308°) and lateral (110°). Three different scenarios were simulated, being the first one without any protection above the phantom's abdomen. Different types of shieldings were used in the second and third scenarios. The added shields, called M1 and M2, were simulated based on the AAPM models proposed in AAPM TG 36 [4], and the impact evaluation of that presence in the dose on the fetus, placenta and amniotic sac was performed.

The simulations were made using tally F6. Th founded results were multiplied by 28, which was considered to be the number of RT sections for a conventional treatment. For each simulation 1.0E8 stories of particles were used, with a mean simulation time of 45h.

Results: Figure 1 shows the effectiveness of the presence of M1 and M2 in reducing dose on the fetus, placenta and amniotic sac in comparison with the situation with no added shield. The reduction, which is shown after taking into consideration the sum of the two fields, also happened in each one of them individually.

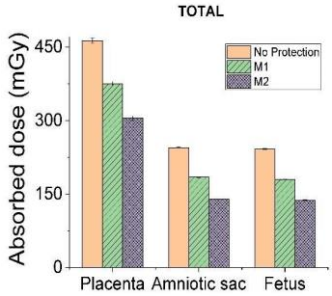

Figure 1: Absorbed dose comparison in the placenta, amniotic sac, and fetus in situations involving no addition of shields and the addition of M1 or M2 [5].

The reduction of the dose on both the structures and the fetus was caused mainly by the lead used to produce the shieldings, which absorbed the scatter radiation from the collimators.

Conclusions: With the found results, it can be concluded that by using a proper shield the reduction on the fetus dose can be in the order of 43%. This value is similar to the reduction in important structures to the fetus development, such as amniotic sac and placenta, when compared with the situation with no shield added.

References:

1.Esposito S, Tenconi R, Preti V, Groppali E, Principi N. Med (United States) 95, 1-6 (2016).
2. Kal HB, Struikmans H. Lancet Oncol 6, 328–333 (2005).
3. Otake M, Schull WJ, Lee S. Int J Radiat Biol 70, 755–763 (1996).
4. Stovall M, Blackwell CR, Cundiff J, Novack DH, Palta JR, Wagner L K. Medical Physics 22,63-82 (1995).
5. Catusso L, Santos WS, RMV Silva,Valença JVB. Physica Medica 84, 24-32 (2021).