DOSIMETRIC EVALUATION OF INHOMOGENEITY EFFECTS IN THE SPINAL CORD

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Modalidade Doutorado

1. INTRODUCTION

The human body consists of a variety of tissues and cavities with diferent physical and radiological properties [1]. The presence of these inhomogeneities will produce changes in the dose distribution, depending on the amount and type of material present and on the quality of radiation [2].

When the irradiation target is located near a critical organ, as often occurs with the spinal cord, the dose is likely to be inhomogeneously distributed across the cord. Although the presence of large heterogeneities, particularly in bony anatomy, are common in clinical practice, the inhomogeneous dose distribution are not accurately accounted for by current generation radiotherapy treatment planning systems [3]. In the clinical setting, these inaccuracies have the potential to affect local tumor control or enhance normal tissue complication probabilities. Therefore, it is of great importance to know the influence and the adverse effects of inhomogeneous dose distributions on the tolerance of the spinal cord [4,5].

2. EXPERIMENTAL

2.1 Vertebral phantom

A simplified phantom was developed to assess the absorbed dose to the spinal cord. The phantom consists of water, and bone equivalent material tissue, in order to simulate soft tissue and spine, respectively.

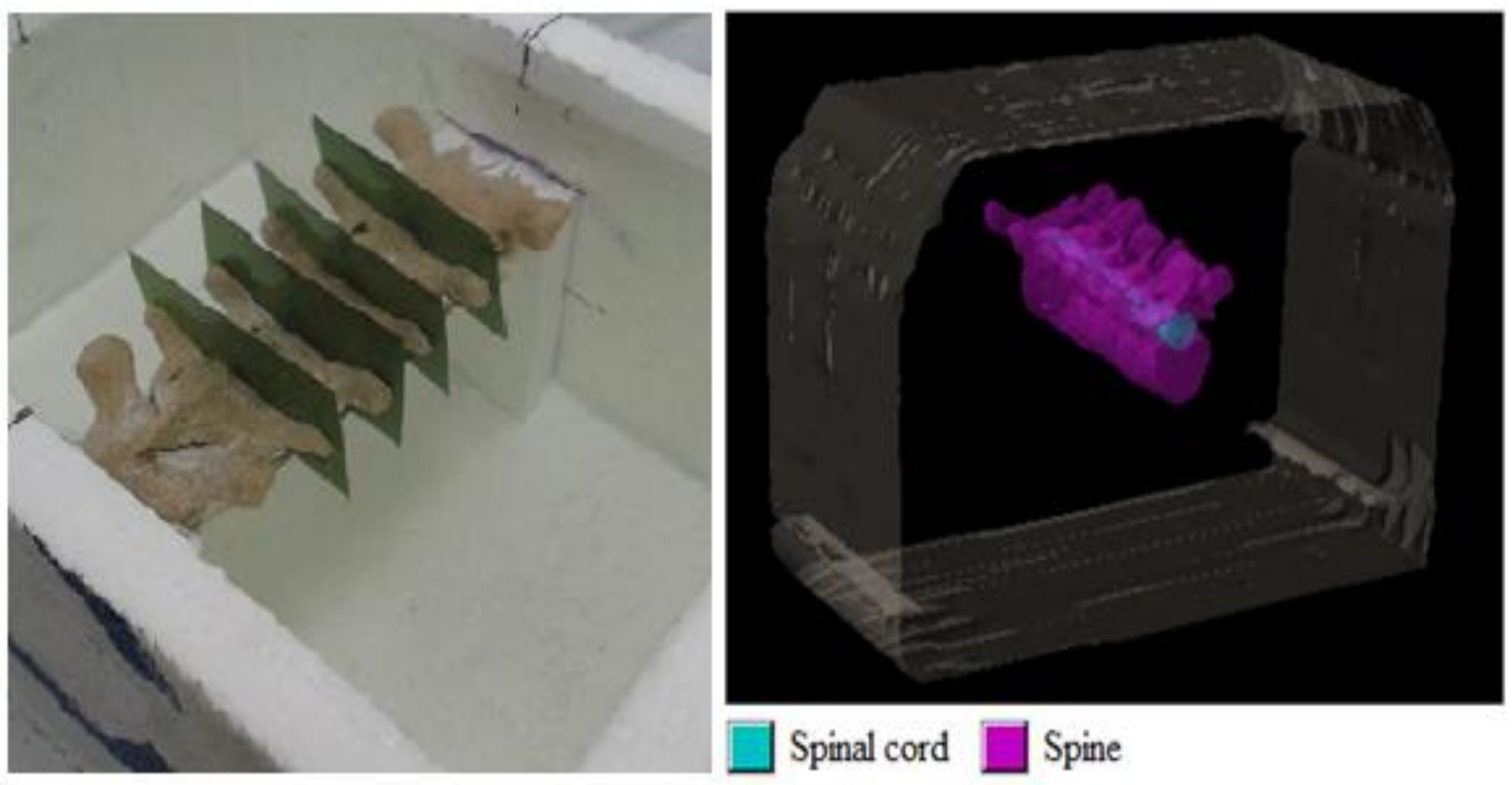
Table 1 Physical and electronic characteristics of tissues and materials

Material	Density (g cm^{-3})	Number of Electrons per Gram (electrons g^{-1})	Electron density (electron cm^{-3})
Muscle	1.00	3.36E+23	3.36E+23
Water	1.00	3.34E+23	3.34E+23
Bone	1.85	3.00E+23	5.55E+23
Bone Phantom	1.80	3.00E+23	5.40E+23

2.2 Simulation and Phantom irradiation

The phantom simulation was performed by a CT scanner GE Health Care Hi Speed CT / and S / N 26794HM7. The software and calculation platform Soma Vision / CadPlan Varian Medical Systems were used for phantom radiotherapy planning.

Fig 1 Films positioning on the vertebral column phantom and Soma Vision phantom reconstruction



3. RESULTS AND DISCUSSION

3.1 Dosimetric analysis of tissue inhomogeneity

Fig 2 Soma Vision / CadPlan dosimetric distribution

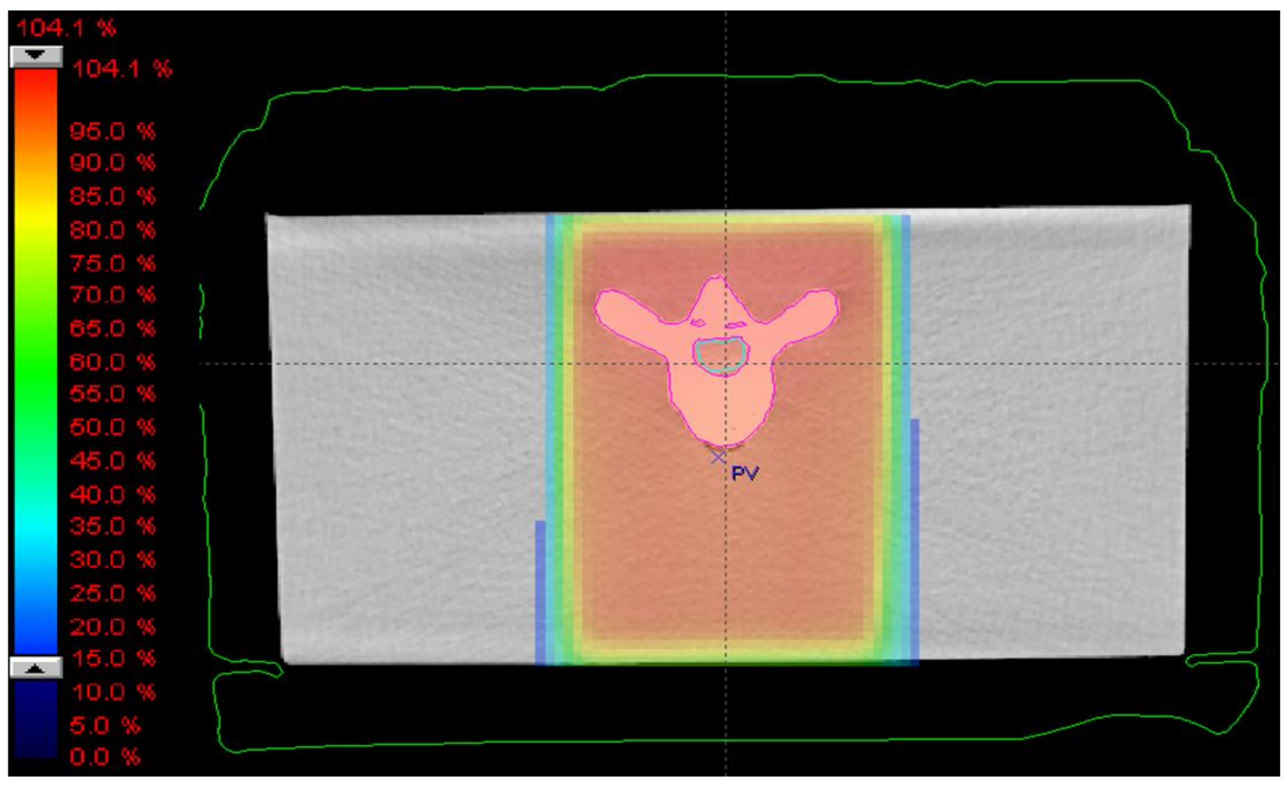
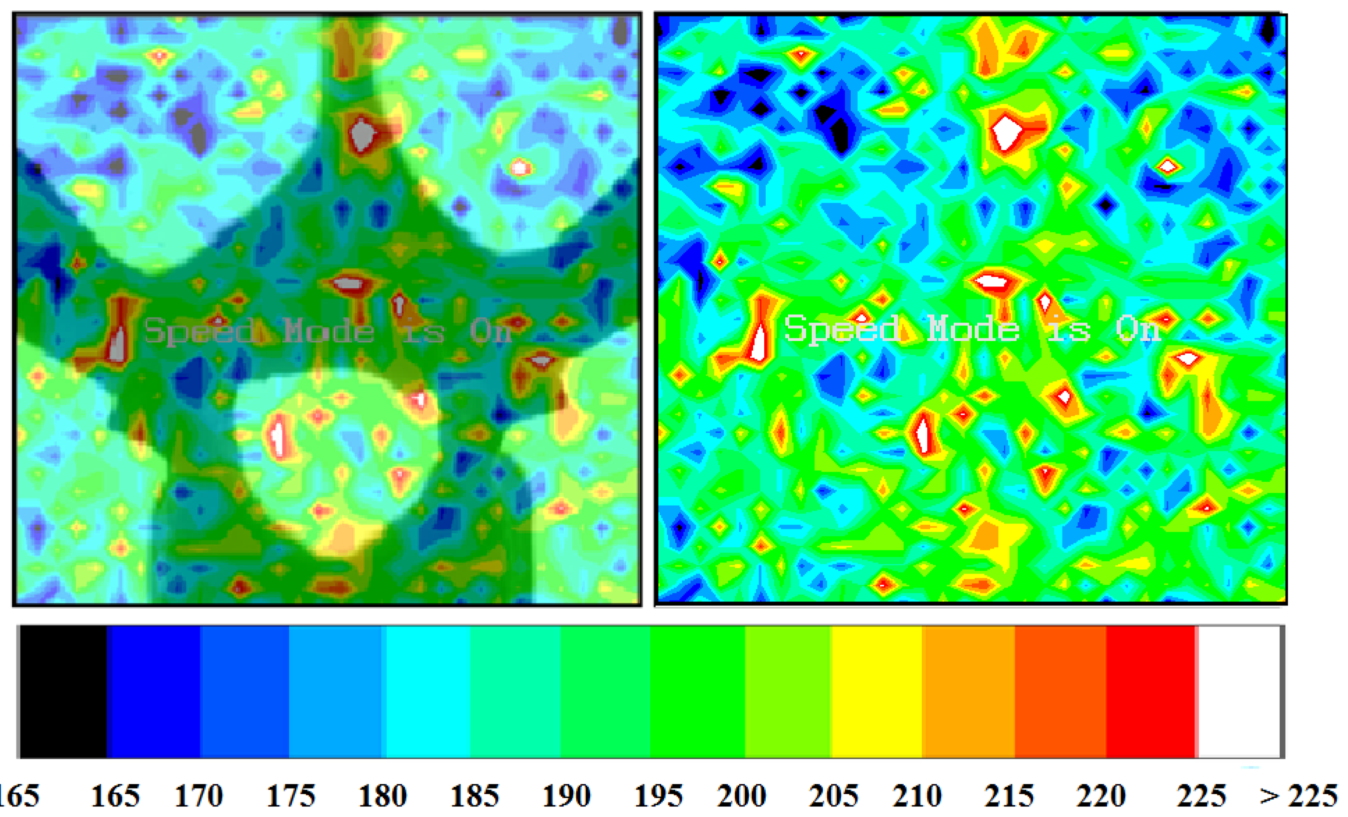


Fig 3 GAFCHROMIC® EBT2 dosimetric distribution



The experiment indicated an overall increase ranging from 5% to 10% of the absorbed dose within the bone and spinal cord, and also point doses of 245 cGy adjacent to bone. Even considering the 6,7% total experimental uncertainty, those values are higher than the absorbed doses predicted by conventional planning systems that do not consider the interaction of secondary electrons. The dosimetric analysis of the films has shown a random distribution of high dose points. It is necessary, therefore, perform the experiment with a larger number of photons interactions with the film in order to generate sufficient statistical data to characterize the behavior and distribution of the absorbed dose.

4. CONCLUSION

The treatment planning system analyzed do not reproduce reliably the absorbed dose within an inhomogeneity. It is evident the importance of searching for new tools and methods such as Monte Carlo N-Particle and experimental simulations to properly access the absorbed doses in tissues and understand the clinic effect of this dose distribution.

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FAPEMIG Fundação de Amparo à Pesquisa do Estado de Minas Gerais
CNPq Conselho Nacional de Desenvolvimento Científico e Tecnológico
CAPES
CDTN Centro de Desenvolvimento da Tecnologia Nuclear
CNEN Comissão Nacional de Energia Nuclear
NRI Núcleo de Radiações Ionizantes