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A study of polymer gel dosimetry and its application

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INTRODUCTION

A new method of dosimetry using polymer gels with MR imaging has been developed by Maryanski et al. since 1994. This polymer gel dosimetry is based on the radiation induced polymerization and cross-linking of acrylic monomer, which are uniformly dispersed in a tissue equivalent gel. Such polymerization is proportional to the absorbed dose and affects the T2 relaxation time among the NMR parameters of the gel. The advantage of polymer gel appears when applied to the verification of complex dose distribution characteristic of radiation field and visualization of three dimensional dose distribution. Therefore, it offers a novel and unique solution to the problem of recording three dimensional dose distribution from complex radiation fields

METHOD

The polymer gel(BANG-2) is composed of 3 % acrylic acid, 1 % NaOH, 5 % gelatin and 88 % distilled water and all percentages are by weight. Three groups of gel phantoms were prepared from the same batch. The group A had a high oxygen level and the group B had a low oxygen level. The phantoms in group C were prepared with different oxygen levels. Group A, B and C were irradiated in a water phantom with 10 × 10 field size by 6 MV photon from a linear accelerator. Group A and B were delivered 0, 3, 6, 9 ,12, 15 Gy each. The group C was irradiated by the same dose to show the oxygen level dependency to radiation.

A 1 liter spherical Pyrex flask was prepared to verify treatment plan for stereotatic radiosurgery. CT images were acquired by attaching fiducial marker around the gel phantom. Using this images, treatment planning were done with a treatment planning computer. Then the gel phantom was irradiated by 6 MV linear accelerator according to the treatment plan. MR images were taken using a GE 1.5T scanner. Images parameters were TR = 1000 ms, TE = 60, 120, 180, 240, 300, 360, 420, 480 ms, 256 × 256 matrix, 2 NEX and 5 mm slice thickness.

RESULTS

The relationship between the dose and $R_2(1/T_2)$ was linear up to 15 Gy for group A and B. But the group B was more sensitive to the radiation. The different oxygen level phantom gave the different dose to R_2 time calibration curve. In group C data higher oxygen level gel phantoms showed lower sensitivity to the radiation linearly. The measured isodose distribution from the gel dosimetry showed a good agreement to the calculated dose distribution from the planning computer.

DISCUSSION

The polymer gel dosimetry is a good way of visualizing dose distribution, but it is strongly affected by the amount of oxygen in the gel. This oxygen dependency of the gel dosimetry is an obstacle for the practical use of the gel. Therefore, it is very important to eliminate oxygen as much as possible from the gel phantom. The characteristic of the polymer gel was also influenced by fabricating procedure. Constant condition in every step of the procedure is necessary to maintain the reproducibility of the gel.

CONCLUSION

The characteristics of the polymer gel dosimetry to oxygen level were studied. In performing the gel dosimetry it is important to maintain the same account of oxygen in the gel. As a gel dosimetry application the dose distribution of a radiosurgery planning was calculated and measured with a gel phantom. This gave a good agreement with each other.