Photoneutron Equivalent Dose Measurements in GRID Therapy Using TLD Types 600/700 and Polycarbonate Film

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INTRODUCTION

Grid therapy, which is also known as spatially fractionated **Grid** radiation therapy (SFGRT) is a method of radiation therapy for treatment of bulky malignant tumors (size > 6 cm).

In this method, a high dose of radiation is deliverd in a single fraction by dividing the treatment field into a set of small open areas. The remainder of the field is blocked by a Grid block or by multileaf collimators (MLCs). It has been proven that a single fraction of high photon dose (10-20 Gy) with Grid therapy has advantages on normal tissue sparing while it is killing the tumor cells. The Grid blocks are generally made of cerrobend or lead.

AIM

The aim of this study is experimental determine the dose contributions from photon and PN in a Grid therapy technique with 18 MV photon beam from a Varian Clinac 2100c linear accelerator (Varian Medical Systems, Palo Alto, California, USA). For photon dosimetry, pinpoint ionization chamber (PTW, Freiburg, Germany) was used in a water phantom. Combination of TLD types 600 and700, and Polycarbonate Film dosimeters were used to measure PN contamination on the surface and in the maximum depth dose (d_{max}) of the beam in Solid Water™ slabs.

METHOD

TLD dosimetry measurement for thermal neutron in Grid field

Combination of TLD-600 (Harshaw, ^{6}LiF: Mg, Ti) and TLD-700 (Harshaw,^{7}LiF: Mg, Ti) were used to measure thermal neutrons equivalent dose in open and Grid fields. TLD-600 has a high thermal neutron capture cross-section while TLD-700 is much more sensitive to photon beam. Both dosimeters have the same dimensions of 3×3×0.9 mm^3.

Polycarbonate dosimeters (PCTD) for fast neutron in Grid field

PCTD dosimeters were used for fast neutron dose measurements in and out of the Grid field. Similar to TLDs experiments, PCTD dosimeters were placed at the center of the hole along the central axis of the beam and in the blocked areas of the Grid field at depth of 3.5 cm and 5 cm. In addition, measurements were performed out of the Grid field at the distance of 5 ,10, 20 cm and 40 cm from the beam edge on the surface of the slab phantom. For both TLD and PCTD dosimetry, each measurement repeated three times, in order to reduce dosimetry uncertainty. 2000 MU was delivered to irradiate PCTD dosimeters with and without the Grid. Finally, the results from with and without Grid block were compared at several points.

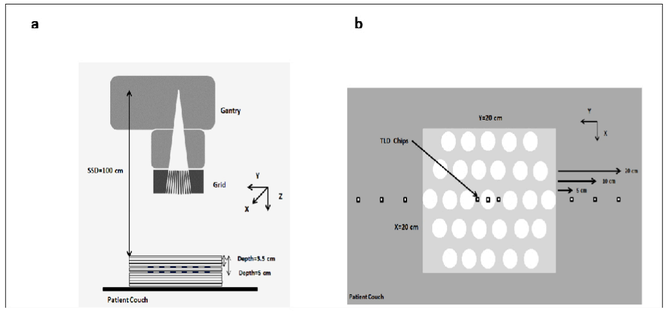

Figure 1- a) Schematic view of the linear accelerator with the Grid Block and TLD chips positions, using solid water™ slabs. b) axial view of TLD chips positions

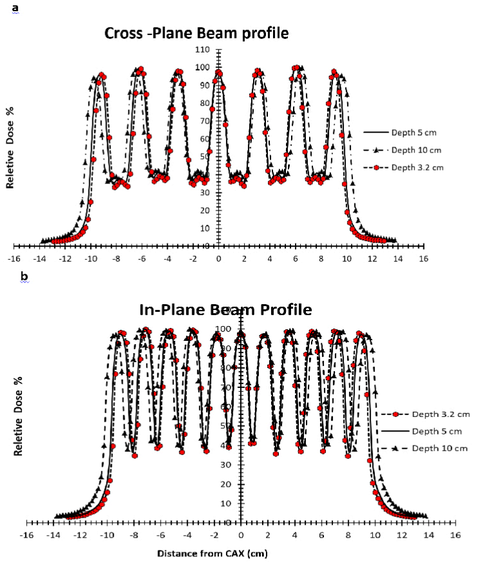

Figure 2- a) Cross-plane and c) In-plane beam profiles of the Grid block for 18 MV photon beam

TLD dosimetry measurement

The calibration curves of TLDs for neutron and gamma doses performed by 18 MV x-ray beam are shown in Figure 3.

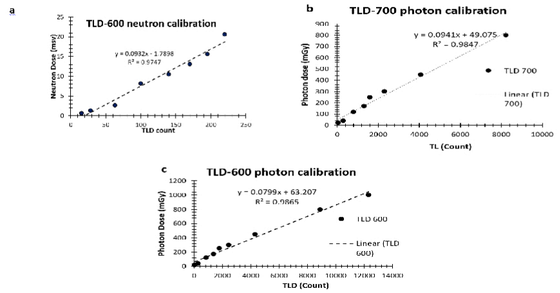

Figure 3- a) TLD-600 neutron calibration curve calculated by using ^{241}Am-Be source. photon calibration curve for b) TLD-700 and c) TLD-600

Table 1- Fast-neutron (F.N) and thermal-neutron (T.N) obtained from PCTD and TLDs 600/700 dosimeters with/without the Grid block on the surface of solid water phantom

	Without Grid (mSv.Gy^{-1})			With Grid (mSv.Gy^{-1})	
Position	PCTD (F.N)	TLD (T.N)	Position	PCTD (F.N)	TLD (T.N)
CAX	2.3	0.76	CAX (hole)	1.89	0.63
			CAX (block)	1.54	0.52
5 cm	0.72	0.21	5 cm	0.56	0.17
10 cm	0.31	0.09	10 cm	0.24	0.06
20 cm	0.19	0.05	20 cm	0.13	0.03
40 cm	0.10	0.03	40 cm	0.07	0.02

CONCLUSIONS

To conclude, based on the findings of this study, production of both fast and thermal neutron dose equivalent was reduced, in the Grid therapy compared to the conventional radiotherapy. Therefore, the use of Grid block with higher energy of photon beam for deep and bulky tumors seems safe. However, it should be considered that continuously using of Grid block in such high energy of photon beam for a long period of the treatment might activate the Grid block.

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