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● Technical Innovations and Notes

STUDY OF ELASTO-GEL PADS USED AS SURFACE BOLUS MATERIAL IN HIGH ENERGY PHOTON AND ELECTRON THERAPY

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Bolus materials are occasionally used during the high energy photon and electron radiation treatments of head, neck, breast, and chest wall areas in order to deliver the full prescribed dose to the skin surface and underlining tissue. Where skin surface curvatures make uniform contact between the bolus material and skin surface difficult, we have studied a new bolus material called Elasto-gel. Elasto-gel, packed in a sterilized envelope, is routinely used in the treatment of superficial burns and wounds. The adhesive nature of Elasto-gel bolus material provides excellent skin contact without air gaps. The Elasto-gel is made of non-toxic material and is transparent. High dose irradiation has no effect on the appearance and property of the Elasto-gel pad. We are presenting in this note the radiation attenuation and build up effects of the Elasto-gel pads of photon energies of 6 and 18 MV and of electron energies of 6 MeV and 20 MeV. There is little difference between Elasto-gel and Polystyrene in radiation dosimetry.

Bolus material, Dosimetry, Photon energy, Electron energy, Elasto-gel.

INTRODUCTION

Bolus material is used in high energy radiation therapy to correct for anatomical irregularities and deliver the prescribed dose to the patient skin surface. Requirements of an ideal bolus material have been suggested by Moyer *et al.* (4). We proposed it should meet the following criteria: have tissue equivalent properties, be made of safe materials approved by FDA, be transparent enough so that skin marks still can be seen, be convenient to use daily and preferably available in commercial packages, and not be altered in appearance after a high dose of radiation. Paraffin wax, super flab, moldable bolus, super stuff, and elastometric polymer have been studied and they are commercially available as bolus materials (1–4). We have studied a new bolus material called Elasto-gel pad, which is routinely used for cast and splint pads and is used in treatment of superficial burns and superficial wounds. Elasto-gel (E-G) is a mixture of water, glycerine, and acrylic polymer, which gels the whole mixture. The E-G has a density of 1.20 gm/cm^3. This material is available in individual packages that may be cut to any desired shape and size. Because of the self-adhesive nature of the gel pieces they may be layered together for various thicknesses.

METHODS AND MATERIALS

The purpose of this note is to compare the percentage of ionization between E-G bolus material and polystyrene for 6 MV, 18 MV photon, energies and for 6 MeV, 20 MeV electron energies (Varian CL 6–100 and CL 20/18X Accelerators). The percentage of ionization is defined as the ratio of the ionization chamber readings at a certain depth to the ionization chamber readings at dmax depth at a fixed target to chamber distance. A Capintec 192 electrometer, capintec PS 033 parallel-plate chamber, and Capintec PP-33 polystyrene phantom (density = 1.04 gm/cm^3) were used in the experiments. The measurements were at 100 cm target to chamber distance for photon studies and were 105 cm target to chamber distance for electron studies. The collimator setting was 10 cm × 10 cm at 100 cm distance from the target for all photon experiments. A 15 cm × 15 cm size electron cone was used for all the electron experiments. Five pieces of E-G pads were used in this study. Their polystyrene equivalent thicknesses are 0.46 cm, 0.40 cm, 0.37 cm, 0.30 cm, and 0.28 cm as calculated by dividing the mass of the pad by its surface dimension and the density of polystyrene (1.04 gm/cm^3).

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Table 1. Data of percentage of ionization measurements of 6 MV and 18 MV photon radiation

		6 MV			18 MV		
Polystyrene equivalent (cm)	Thickness in materials	% of ionization	Polystyrene only	Difference	% of ionization	Polystyrene only	Difference
0.5	Elasto-gel only	85.6	85.1	0.5	55.2	57.8	2.6
0.9		97.3	97.0	0.3	73.5	75.0	1.5
1.2		100.0	99.8	0.2	84.0	82.0	2.0
1.5		100.0	100.0	0.0	90.0	87.5	2.5
1.8		99.5	99.8	0.3	93.7	91.0	2.7
2.5	2 cm Polystyrene + Elasto-gel				97.1	97.0	0.1
2.9					98.8	99.0	0.2
3.2					99.8	99.7	0.1
3.5					100.0	100.0	0.0
3.8					100.2	100.2	0.0
4.5	4 cm Polystyrene + Elasto-gel				99.8	99.7	0.1
4.9					99.4	99.2	0.2
5.2					98.8	99.0	0.2
5.5					98.1	98.5	0.4
5.8					97.4	97.8	0.4
5.5	5 cm Polystyrene + Elasto-gel	90.0	89.8	0.2			
5.9		88.7	88.5	0.2			
6.2		87.6	87.5	0.1			
6.5		86.6	87.0	0.4			
6.8		85.6	86.0	0.4			
10.5	10 cm Polystyrene + Elasto-gel	75.2	75.0	0.2	88.7	88.6	0.1
10.9		74.0	74.0	0.0	87.9	87.6	0.3
11.2		72.7	73.0	0.3	87.3	87.0	0.3
11.5		71.8	72.3	0.5	86.6	86.3	0.3
11.8		70.8	71.3	0.5	86.0	85.7	0.3

Table 2. Data of percentage of ionization measurements of 6 MeV and 20 MeV electron radiation

		6 MeV			20 MeV		
Polystyrene equivalent (cm)	Thickness in materials	% of ionization	Polystyrene only	Difference	% of ionization	Polystyrene only	Difference
0.5	Elasto-gel only	89.8	90.0	0.2	96.9	95.5	1.4
0.9		97.2	97.0	0.2	97.8	97.2	0.6
1.2		100.0	100.0	0.0	98.9	98.6	0.3
1.5		93.9	98.0	4.1	100.0	99.0	1.0
1.8		78.9	84.0	5.1	99.6	99.5	0.1
2.5	2 cm Polystyrene + Elasto-gel	44.5	40.0	4.5	99.7	99.6	0.1
2.9		14.5	12.5	2.0	99.6	99.2	0.4
3.2		2.3	3.0	0.7	98.9	98.5	0.4
3.5		1.2	1.0	0.2	98.6	98.0	0.6
3.8		1.2	1.0	0.2	97.8	97.2	0.6
4.5	4 cm Polystyrene + Elasto-gel				96.9	95.5	1.4
4.9					95.0	94.0	1.0
5.2					93.2	92.5	0.7
5.5					91.4	91.0	0.4
5.8					88.9	89.0	0.1

RESULTS AND DISCUSSION

With Elasto-gel pads only, or with various thickness of polystyrene plates (2 cm, 4 cm, 5 cm, and 10 cm), between the pancake chamber and the E-G pads, the percentage of ionization of the 6MV and 18MV photon beams was measured at various depths. The results are presented in Table 1. Table 1 also presents the percentage of ionization in polystyrene phantom. The differences between these two sets of data are also shown in the Table 1. In the steep dose gradient region of 18 MV photon beam (depth less than 2 cm) the maximum difference is 2.7%. In the region of linear dose decrease of photon beams (depth beyound the maximum build up) that the maximum difference is 0.5%.

The data of percentage of ionization measurements with E-G pads only and with polystyrene plates plus E-G pads for 6 MeV and 20 MeV electron beams are presented in Table 2. The large differences (maximum 5.1%) in the region of linear dose decrease of the 6 MeV percentage of ionization curves between E-G and polystyrene probably resulted from the uncertainty of the depth measurement of ± 1 mm. The maximum difference of the percentage of ionization of 20 MeV electron beam between E-G and polystyrene material is 1.4%. In the case of electron beam measurements, that the report percentage of ionization measurements are not dose measurements since no correction been made for convert ionization measurements to dose as described in the AAPM protocol (5).

Our study shows that the E-G bolus material and polystyrene are interchangeable in the dosimetry calculation as long as the polystyrene equivalent thickness of the E-G pad is calculated. A sample was irradiated to a dose of 100 Gy with no observable damage to its appearance or property. The biggest advantage of this E-G pad as bolus material is the convenience of usage in the patient's daily radiation treatment. The cost of E-G pads is relatively inexpensive compared to the other available bolus materials in the market. The deficiency is that the gel nature of this E-G pad made the thickness measurement difficult. The manufacture has not yet been able to supply a batch of E-G pads with exact the same thickness; therefore, each pad has to be measured in thickness individually.

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