Anne Arundel Medical Center
DeCesaris Cancer Institute

Bolusing Effect of Fiberglass Material for 6MV Photon Beam Treatments with Parallel Plate and Gafchromic Film

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INTRODUCTION

The advancements in imaging, diagnosis testing, and treatment delivery have increased the 5 year survival rate for Cancer patients in the United States[1]. However, many patient's living longer with cancer return to Radiation Oncology centers for treatment of metastatic disease. Some patients arrive in departments with fiberglass casts, and other medical devices to stabilize areas of bone weakness and fracture. The effect of the casting material on the radiation distribution has not been evaluated in the literature. The expectation is the casting material would act as a blousing agent on the skin of a patient undergoing radiation therapy treatment.

AIM

This study was designed to measure the blousing effect of standard fiberglass appendage casting material used for stabilizing bone fractures associated with metastatic disease.

METHOD

Delta-Cast Fiberglass casting materials were acquired in 1mm thicknesses. A total of 10 strips were obtained. Each strip was cast separately with the recommended stabilizer, and allowed 24 hours to cure (See Image 1).

Once cured CT scans were obtained for thicknesses of 1mm to 6mm of cast material on top of a 10cm solid water phantom. Scans were obtained with a Siemens Definition scanner. The HU value for the casting material was measured. The scans for each thickness of material were networked to the Eclipse treatment planning system. (See Image 2).

Using the ACUROS treatment planning algorithm plans were developed for each thickness of cast material. Each plan was setup to deliver 100MU's to the cast material using a 6MV 10x10 treatment field. (See Image 3).

Plans were networked to the Truebeam accelerator for exposure.

Initial plan deliveries were done with a Exadrin P11 Parallel Plate ionization chamber placed in a solid water phantom. The phantom positions the surface of the Parallel Plate chamber at the surface of the solid water.. 100cm SSD exposures were delivered with casting material thicknesses form 0mm to 6mm as per the plans.. (See image 2,)

Using the same solid water phantom and thicknesses of casting material, exposures were done with EBT3 Gafchromic film in place of the parallel plate chamber. For Gafchromic film exposures 500MU's were delivered for each exposure.

A third set of measurements was collected. In addition nto the casting material a layer of cotton mesh used with the casting material was introduced between the solid water phantom and the casting material.

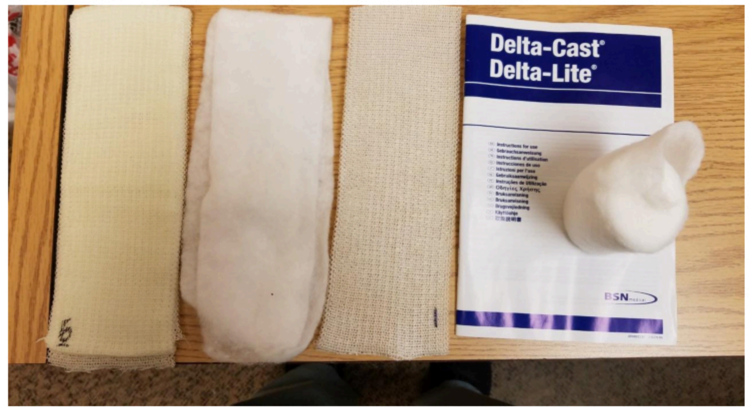


Image 1) Delta cast , fiberglass casting kit. 6mm casted material (6 layers), cotton mesh 1mm (1 layer) casted material.

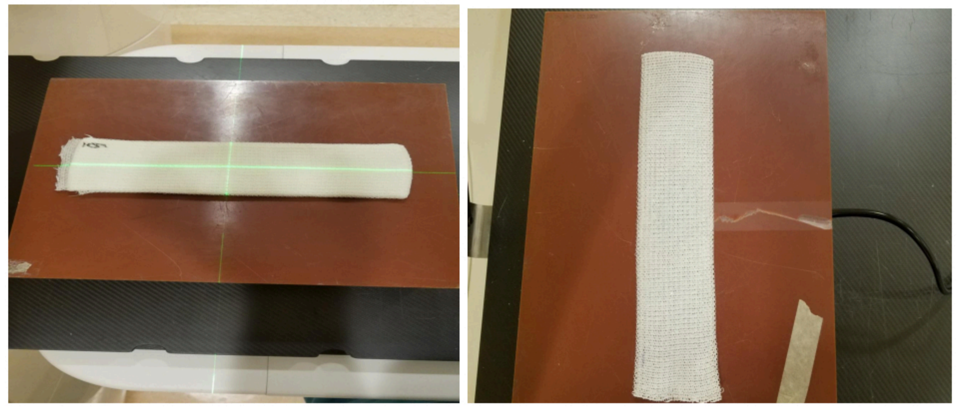


Image 2) 10cm solid water phantom with 6mm of fiberglass cast for gafchromic film measurements, and 1mm Fiberglass cast for parallel plate measurements.

Image 3) Isodose plots for a 10cm solid water phantom with 6mm of fiberglass cast for a 6MV 10x10 field art 100cm SSD. Left image is calculated with AAA and right image is calculated with ACUROS. Note: The inhomogeneity of the fiberglass cast material (HU range -350 to -430).

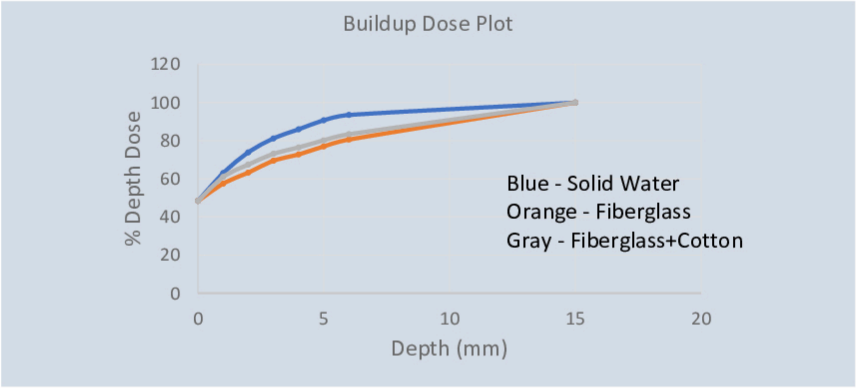
RESULTS

The surface dose for this flattened 6MV beam was 48.4% as measured with the parallel plate chamber, and 48% measured with EBT3 film.

Table 1 shows the increase in dose as the depth in solid water is increased from 0mm to 15mm. Table 1 also shows the increase in dose at the same depths for fiberglass casting material, as well as, fiberglass casting material and cotton mesh. The dose in all three arrangements increases as the depth increases. The increase in dose is least for the Fiberglass casting material alone. The increase in dose increases with the addition of cotton mesh. Graph 1 shows the three plots of the dose buildup.

Solid Water		Fiberglass Cast			Fiberglass Cast+Cotton		
Depth (mm)	Dose (cGy)	Depth (mm)	PP (cGy)	Film(cGy)	Depth (mm)	PP(cGy)	Film (cGy)
0	48.4	1	57.5	61.4	1	63.0	62
2	73.9	2	63.3	65.8	2	67.5	66.9
3	81.2	3	69.5	71.6	3	73.1	74.2
5	90.7	4	72.8	74	4	76.5	78.5
damx	100	5	77	78.9	5	80.2	81
		6	80.6	86	6	83.4	84

Table 1) Depth dose measurements for thicknesses of solid water, Fiberglass, and Fiberglass + Cotton mesh. Measured with Parallel Plate Chamber and Gaf-chromic film.



Graph 1) Build up Dose plot for thicknesses of solid water (Blue), Fiberglass (Orange),and Fiberglass + Cotton mesh (Gray).

1mm of Fiberglass casting material increases the dose by 9%, and the addition of the cotton mesh increase the dose by approximately 15%. Beyond 1mm of buildup the dose increase with the Fiberglass casting materials is approximately 16% less than the solid water dose. Similarly, the dose is approximately 12% less than the solid water dose increase with depth. The decrease in dose is consistent through 6mm of depth and begins to converge as the depth approaches dmax.

The addition of the cotton mesh increases the dose at each point in the buildup region by approximately 5%. After 6mm the two curves begin to converge until they are equal close to the dmax depth. The Fiberglass and Fiberglass+cotton mesh curves are nearly identical but separated by 5% throughout the 6mm buildup region.

CONCLUSIONS

The Fiberglass casting material used for reinforcing weakened appendages does cause a blousing affect of the dose during delivery of radiation therapy using 6MV photon beams. The buildup in dose from this bolusing affect is approximately 16% less than the buildup for tissue from 1mm to 6mm. With standard casting of appendages a cotton mesh is placed between the patients skin surface and the fiberglass cast. The mesh is used to provide a soft surface between the skin and the cast. The cotton mesh increases the dose by approximately 5% as compared to the Fiberglass alone, and is approximately 12% lower than tissue in the buildup region.

Measurement of the Hounsfield Units (HU) for the Fiberglass casting material had some variation. The HU values for a 1mm layer of fiberglass was -550HU, and -400HU for 6mm of fiberglass. The uncertainty for each case was approximately 70HU. In addition, within the layers of the Fiberglass the HU varied due to the construction of the Fiberglass cast.

This research has determined there is a blousing affect related to fiberglass casting used for appendage stabilization. Continuation of this research will be looking at photon energies of 10MV, and 15MV. Additionally, work has begun looking at the affect with electron beams. However, it is not standard for shallow tumors, and skin cancers to be treated when there is casting material present.

This research project is important since we are seeing more patients returning with metastatic disease. Many patients with metastatic disease have weakened appendages and require stabilization measures. Accounting for the stabilization devices are critical for determining the clinically delivered dose.

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REFERENCES

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1. *Cancer Facts & Figures 2019*, Pg. 3, American Cancer Society, Atlanta, Georgia
2. .Delta-Cast, BSN Medical, Charlotte, North Carolina.
3. Gafcromic EBT3 Film, Radiation Products Design, Albertville, Minnesota.

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