

가 GafChromic Film

*, †

*, †, *, *, †, †

____: 가 GafChromic
 _____: 가
 (MD - 55 - 2, Nuclear Associate, USA) 5 c m GafChromic
 Gy , Digitizer (Optical density: OD) 6 MV , 0 ~ 112
 ' Linapel ' (Isocenter of Target)
 , 300 cGy 5 arc (RIT113
) 5 arc 가 GafChromic

____: MD - 55 - 2 GafChromic 가
 (profile) GafChromic
 ' Linapel '
 가 ±3% , GafChromic
 50 ~ 90% ±1 mm 가

____: GafChromic
 , 가

: , GafChromic , , ,

가 McLaughlin³⁾ 가
¹⁾ ²⁾
 (6 ~ 10 MV)
 (± 1 mm
³⁾

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(Thermoluminescence: TLD)가

(dose rate) , TLD

가

Radiography

RadioChromic

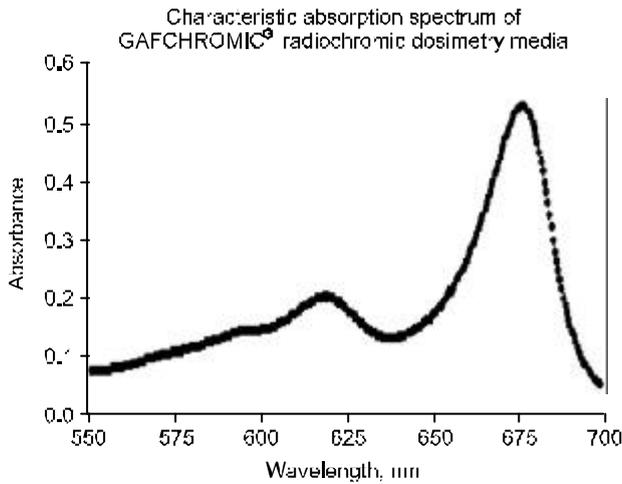


Fig. 3. Characteristic absorption spectrum of GafChromic radiochromic dosimetry media (major absorbance peak: 675 nm, minor peak: 615 nm for 6 MV photon) (Provided by nuclear associates, NY, USA).

RadioChromic

가

가 가
가

RadioChromic

1990 Bjarngard⁴⁾가

1994

McMaughlin³⁾

RadioChromic

RadioChromic

GafChromic

HD - 810, DN - 1260,

RadioChromic
DM - 100, MD - 55 - 2

GafChromic MD - 55 - 2
MD - 55 - 2 GafChromic

Linapel⁵⁾

GafChromic

GafChromic

가

GafChromic

1. Lumiscan 75 Digitizer

Lumiscan 75 digitizer (Lumiscan 75 laser digitizer, Lumisys Inc, USA) (He - Ne Laser; 632.8 nm, ; 0.1 mm) digi - tizer
0.001 lp/mm 가 3.500
(OD) . 0.01 2.5
14" x 28" 0.099 mm² 5" x 7"
115

2. GafChromic Film

GafChromic Nuclear
Associate MD - 55 - 2
37 - 041 MD - 55 - 2 GafChromic
(Nuclear Associate, USA)가
Fig. 1 가

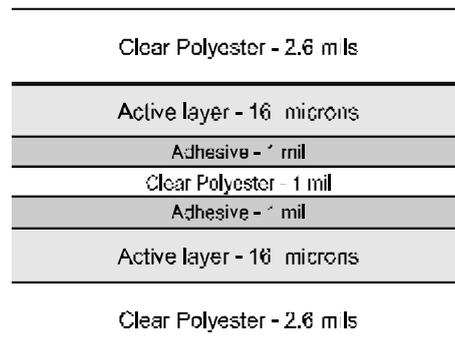


Fig. 1. Configuration of GafChromic dosimetry film; MD - 55 - 2 (Provided by nuclear associates, USA).

(Ultraviolet)

(Fig. 2).

MD - 55 - 2 GafChromic

Fig. 3

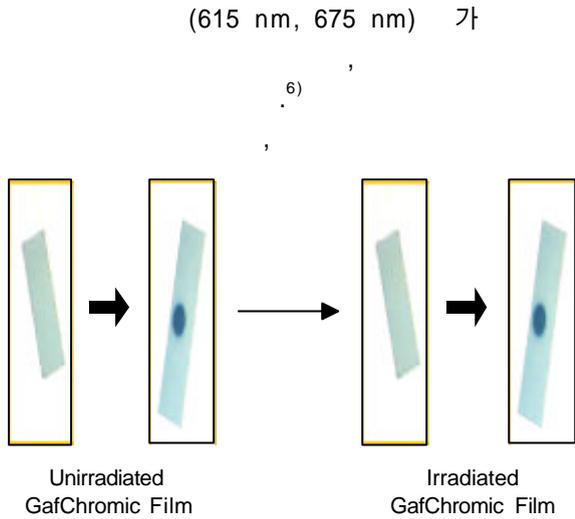


Fig. 2. Un-irradiated GafChromic film & irradiated GafChromic films.

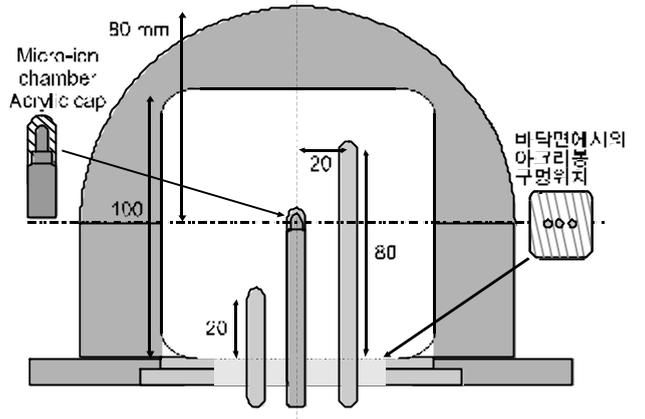


Fig. 4. Spherical Acrylic Phantom, simulating a patient head.

24 가 60 °C
 HD - 810 50 ~
 MD - 55 - 2 15 ~
 2,500 Gy
 3 ~ 100 Gy
 25 Gy
 가
 MD - 55 - 2

M6740 (Siemens, Germany) 6 MV
 GafChromic 24
 Lumiscan 75 digitizer
 GarChromic
 5 cm
 가 10 x 10
 cm², SSD 100 cm,
 0 Gy 112 Gy 가 4 Gy
 2) (Dosimetry)

3. (Human Head Style Acrylic Phantom)
 Fig. 4 8 cm
 10 cm

Linapel 20
 mm 5 arc
 300 cGy 1,500 cGy가

가
 (Micro Chamber; Extradin A - 14, USA, 0.009
 cc) (Electrometer: M500, Victoreen, USA)

GafChromic

4.
 1)
 13 x 13 cm² MD - 55 - 2
 GafChromic 가
 GafChromic
 1.5 x 1.5 cm² 3 x 3 cm²
 Siemens

가
 RIT113 (RIT Inc., USA)
 1,500 cGy GafChromic

1.
 MD - 55 - 2 GafChromic
 Fig. 5

가 1, 2

3

(Fitting)

$$y = ax^3 + bx^2 + cx + d, \quad a = 2 \times 10^{-9}, \quad b = 5 \times 10^{-5}, \\ c = 0.0148, \quad d = 1.5392$$

Fig. 5

가 가 (15 ~ 30 Gy)
MD - 55 - 2 GafChromic

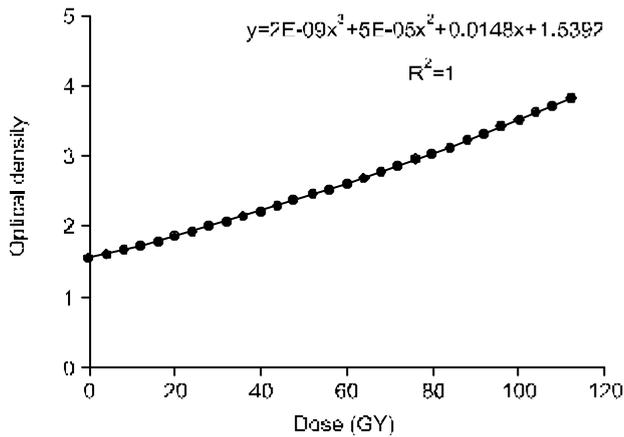


Fig. 5. Calibration curve (Optical density vs. radiation dose) for GafChromic film MD - 55 - 2; Nuclear Associate.

2.

GafChromic

1.5 cm 6 MV GafChromic 가
D_{max}가 (10 ~ 20 cm) Fig. 6 가 3 ~ 4% . Fig. 7

GafChromic

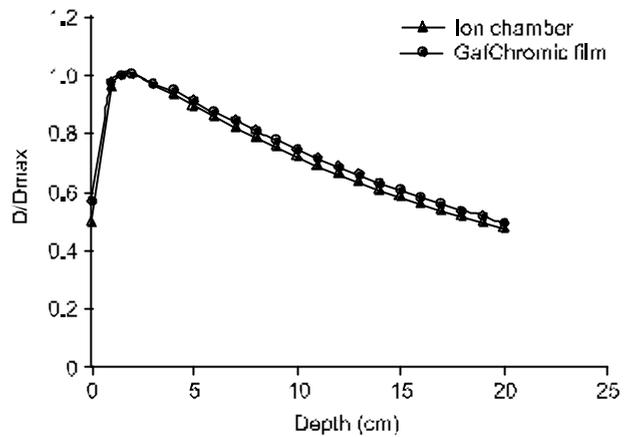


Fig. 6. Depth dose for a 6 MV photon field with Ion chamber and GafChromic film (field size: 10 x 10 cm², SSD: 100 cm).

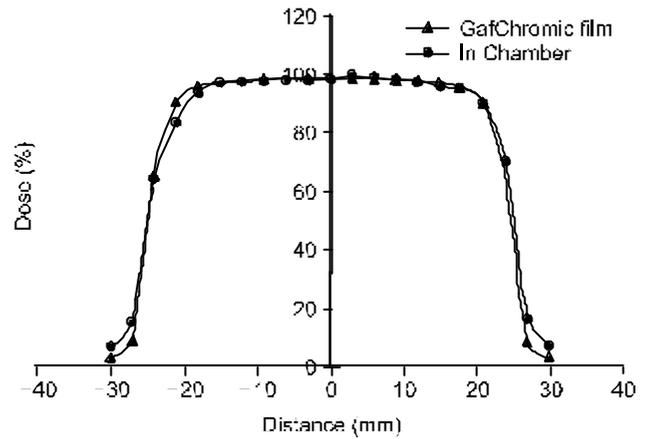


Fig. 7. Dose cross profile along the x-axis for a 6 MV photon field with Ion chamber and GafChromic film.

가 (-24 mm +24 mm)
4% 가 .

3.

GafChromic
Fig. 8 . 90%, 50%, 30%
Linapel

(Target Isocenter)

6 MV , 5

0.8 mm, 50% 1.2 mm,

가 90%

300 cGy

2.5 mm

30%

arc
1,500 cGy

GafChromic

Table 1

1498.54 cGy , GafChromic

1455.46 cGy . TLD, ,

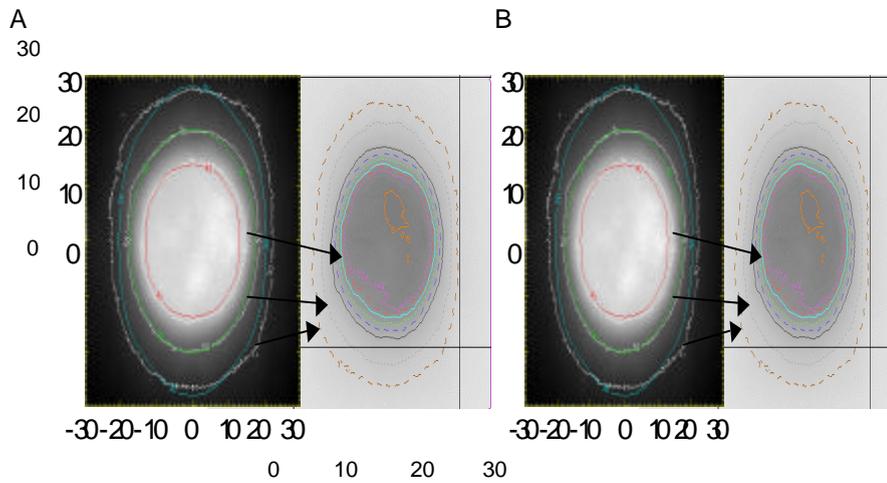


Fig. 8. Relative dose distribution curves. (A) Comparison of calculated isodoses for radiosurgery treatment with those measured using GafChromic film MD-55-2 in a spherical acrylic phantom, simulating a patient head, irradiated to a dose 1500 cGy, (B) measured isodose curve which process with the RIT113 film dosimetry system.

Table 1. Absolute Dose Measurement (Gafchromic Film MD-55-2 and Micro Chamber) and Treatment Planning Calculation (Linapel radiosurgery planning system), 5 arc Beam, 20mmCone, 1500cGyatIsocenter

Beam Arc	Dose measurement (cGy)		Dose prescription (cGy)	Error (%)	
	Ion - chamber	Gafchromic film		Ion - chamber/Prescription	Gafchromic/Prescription
1	299.35	290.78	300	-0.20	-3.10
2	298.48	293.71	300	-0.50	-2.30
3	300.21	296.20	300	0.07	-1.30
4	300.18	289.36	300	0.06	-3.50
5	300.32	285.41	300	0.10	-4.80
Total	1498.54	1455.46	1500	-0.47	-3.00

1)

99.8% , GafChromic

7)

97%

가 ± 3%

가
 GafChromic 가
 가
 GafChromic (±3% , 1 mm)
 MD - 55 - 2 가 profile 가
 . 1 mm 가 GafChromic 가
 Digitizer GafChromic 가
 가 GafChromic 가
 가 G.R.Gluckman⁸⁾
 6 MV MD - 55 - 2 GafChromic
 0 ~ 112 Gy
 가
 15 ~ 30 Gy
 가
 , Linapel 5 arc
 300 cGy 1,500 cGy
 99.8%가
 -0.2% , GafChromic
 97%가 - 3%
 . GafChromic
 5 - 4.8% 가
 Table 1
 RIT113
 90 ~ 30% 50% 1
 mm
 , 30% 2.5 mm
 GafChromic
 가 가
 가 Digitizer
 가⁸⁾

MD - 55 - 2 GafChromic 가
 가 가
 GafChromic 가
 가
 (Penumbra)
 가
 GafChromic
 1. Heydarian M, Hoban PW, Beddoe AH. A comparison of dosimetry techniques in stereotatic radiosurgery. Phys Med Biol 1996;41:93 - 110
 2. Stanislav M. Radiochromic film dosimetry for clinical protonbeams. ApplRadiatIsot1997;48(5):643 - 651
 3. MclaughlinWL, SoaresCG, SayegJA, etal. The use of a radiochromic detector for the determination of stereotactic radiosurgery dose characteristics. Med Phys 1994; 21(3):379 - 388
 4. Bjarngard BE, Tsai JS, Rice RK. Doses on the central axes of narrow 6 MV x-ray beams. Med Phys 1990;17: 794 - 799
 5. ChoBC, OhDH, BaeHS. Development of a stereotactic radiosurgery planning system. Korean Journal of Medical Physics 1997;8:17 - 24
 6. Gafchromic radiochromic dosimetry films background information. ISP inc Wayne New jersey USA, <http://www.isp.com/products/dosimetry/products/>
 7. Niroomand-Rad A, Blackwell CR, Coursey BM, et al. Radiochromic film dosimetry: Recommendations of AAPM

Abstract

GafChromic Film Dosimetry for Stereotactic Radiosurgery with a Linear Accelerator

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Purpose: The purpose of this study was to evaluate whether a GafChromic film applied to stereotactic radiosurgery with a linear accelerator could provide information on the value for acceptance testing and quality control on the absolute dose and relative dose measurements and/or calculation of treatment planning system.

Materials and Methods: A spherical acrylic phantom, simulating a patient's head, was constructed from three points. The absolute and relative dose distributions could be measured by inserting a GafChromic film into the phantom. We tested the use of a calibrated GafChromic film (MD - 55 - 2, Nuclear Associate, USA) for measuring the optical density. These measurements were achieved by irradiating the films with a dose of 0 - 112 Gy employing 6 MV photon. To verify the accuracy of the prescribed dose delivery to a target isocenter using a five arc beams (irradiated in 3 Gy per one beam) setup, calculated by the Linapel planning system the absolute dose and relative dose distribution using a GafChromic film were measured. All the irradiated films were digitized with a Lumiscan 75 laser digitizer and processed with the RIT113 film dosimetry system.

Results: We verified the linearity of the Optical Density of a MD - 55 - 2 GafChromic film, and measured the depth dose profile of the beam. The absolute dose delivered to the target was close to the prescribed dose of Linapel within an accuracy for the GafChromic film dosimetry (of $\pm 3\%$), with a measurement uncertainty of ± 1 mm for the 50 ~ 90% isodose lines.

Conclusion: Our results have shown that the absolute dose and relative dose distribution curves obtained from a GafChromic film can provide information on the value for acceptance. To conclude the GafChromic film is a convenient and useful dosimetry tool for linac based radiosurgery.

Key Words: Stereotactic radiosurgery, GafChromic film, Absolute dose, Relative dose, Optical density