A Convenient System for Film Dosimetry Using NIH-image Software

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ABSTRACT

An accurate measurement of dose distribution is indispensable to perform radiation therapy planning. A measurement technique using a radiographic film, which is called a film dosimetry, is widely used because it is easy to obtain a dose distribution with a good special resolution. In this study, we tried to develop an analyzing system for the film dosimetry using usual office automation equipments such as a personal computer and an image scanner. A film was sandwiched between two solid water phantom blocks (30 × 30 × 15cm). The film was exposed with Cobalt-60 γ-ray whose beam axis was parallel to the film surface. The density distribution on the exposed film was stored in a personal computer through an image scanner (8bits) and the film density was shown as the digital value with NIH-image software. Isodose curves were obtained from the relationship between the digital value and the absorbed dose calculated from percentage depth dose and absorbed dose at the reference point. The isodose curves were also obtained using an Isodose plotter, for reference. The measurements were carried out for 31cGy (exposure time: 120seconds) and 80cGy (exposure time: 300seconds) at the reference point. While the isodose curves obtained with our system were drawn up to 60% dose range for the case of 80cGy, the isodose curves could be drawn up to 80% dose range for the case of 31cGy. Furthermore, the isodose curves almost agreed with that obtained with the isodose plotter in low dose range. However, further improvement of our system is necessary in high dose range.

Keywords: Radiotherapy planning, Film dosimetry, Dose distribution,

1. INTRODUCTION

In radiation therapy field, especially radiation therapy planning, measurement of dose distribution inside a body of patient is indispensable to carry out the most suitable irradiation. A measurement method using a radiographic film, which is called a film dosimetry, is widely used because it is easy to obtain a dose distribution with a good special resolution[1-2]. From the handiness of this technique, film dosimetry is being used widely for not only the radiation therapy planning but also QA/QC of the treatment unit. And, film dosimetry is also being used actively for the study and dose evaluation of the complex irradiation technique that develops rapidly, such as IMRT (Intensity Modulated Radiation Therapy) and radiosurgery[3-4]. The dose distribution by film dosimetry has been obtained using automatic iso-density curve drawing unit, like an Isodose plotter[5]. Recently, some computerized analyzing system for film dosimetry has been developed. However, those systems are very expensive, so, no facilities can always introduce it. So, in this study, we tried to develop an analyzing system for the film dosimetry using usual office automation equipments such as a personal computer and an image scanner.

2. MATERIALS AND METHODS

2.1. Preparing procedure of sample films

To prepare films for calibration (calibration film) and for isodose curve measurement (measurement film), we used the following procedures in this study. A film that every sheet was covered with a black paper to protect from light (Kodak READY PACK X-OMAT), was sandwiched between two solid water phantom blocks (30 × 30 × 15cm). The film was exposed with ^{60}Co γ-ray (Shimadzu RTGS-21-22) whose beam axis was parallel to the film surface on the condition that is showed in Table 1. And, those exposed film were processed with a KONICA X-RAY AUTOMATIC PROCESSOR KX-130 (processing time 120seconds

Table 1. Exposure condition

Sample \ Condition	Exposure time [seconds]	Absorbed dose at reference depth
Calibration film	150	39.2[cGy]
	300	79.6[cGy]
Measurement film	120	31.4[cGy]
	300	79.6[cGy]

All sample: SSD=80cm, Field size: 10 × 10cm^2

and temperature 35°C). By the procedure above, we obtain 4 sample films.

2.2. Isodose curve measurement procedure using NIH-image software

First, the density distribution on the sample film was stored as a digitized image in a personal computer through an image scanner (8bit, TIFF format) using a procedure that sample film was sandwiched between an image scanner (EPSON GT-7600S, Its resolution is 8bit) and small size X-ray view box (FUJICOLOR Color Illuminator Pro B4, Its luminance is 1500cd/m^2). By that procedure, film density was converted into digital value, and the film density distribution was shown as the digital value distribution on NIH-image software. The digital value distribution was shown at Look Up Table (LUT) as a relationship between digital value and gray scale.

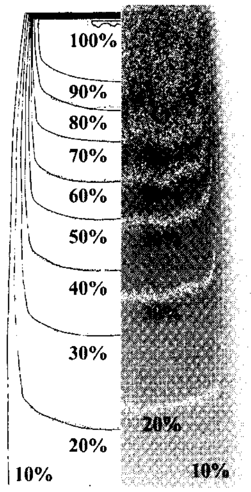

Figure 1. Dose distribution
(Sample film: 300seconds)
Isodose plotter | NIH-image

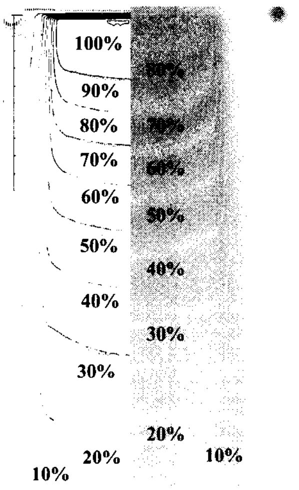

Figure 2. Dose distribution
(Sample film: 120seconds)
Isodose plotter | NIH-image

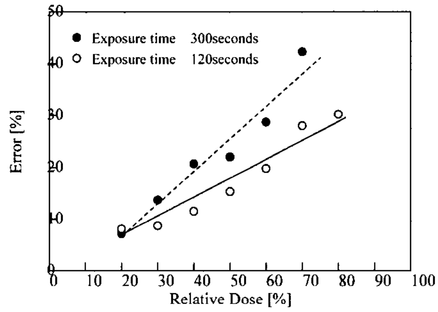

Figure 3. The error of NIH-image software to isodose plotter about the depth from the surface of phantom to each isodose curves.

Next, from the digital value distribution of calibration film, percentage depth dose (PDD) of ^{60}Co γ-ray and absorbed dose at the reference point, we obtained a relationship between absorbed dose and digital value as calibration curve. After that, we decided a maximum digital value on a measurement film as a digital value for maximum absorbed dose. From the maximum digital value and the calibration curve, we calculated relationships between relative absorbed dose for the maximum absorbed dose and digital value, from 100% dose range to 10% dose range in steps of 10%. Finally, gray scale of the digital value which equivalent to each relative dose was changed on LUT, and we obtained isodose curve. The isodose curve was also obtained using an Isodose plotter (SAKURA ISODENSITY RECORDER PDI-10) for reference. In this study, isodose curve of the measurement film of the 300seconds exposure was obtained using calibration curve of 300seconds exposure, and that of the measurement film of the 120seconds exposure was obtained using calibration curve of 150seconds exposure.

3. RESULS

Figure 1 and 2 compares isodose curves between by Isodose plotter and by NIH-image software. Figure 1 was carried out for 300seconds exposure, Figure 2 was carried out for 120seconds exposure. While the isodose curves obtained with our system were drawn up to 60% dose range for the case of 300seconds, the isodose curves could be drawn up to 80% dose range for the case of 120seconds. With the dose range beyond them, each isodose curves were not separated clearly in the both cases. And, isodose curves of Isodose plotter and NIH-image software didn't correspond in all dose range. Figure 3 shows the error of NIH-image software to Isodose plotter about the depth from the surface of phantom to each isodose curves. We know from Figure 3 that the lower the absorbed dose is, the smaller the error becomes. And, isodose curve of 120seconds exposure has a fewer errors than that of 300seconds exposure. This tendency is seen with high-absorbed dose area remarkably. The calibration curve that used for drawing isodose curve by Isodose plotter (film density distribution) is shown in the Figure 4. And the calibration curve that used for drawing isodose curve by NIH-image software (digital value distribution) is shown in the Figure 5. While the calibration curve for Isodose plotter showed a good linear increase from low-absorbed dose area to high-absorbed dose area, the calibration curve for NIH-image software was showed a good linear increase in low-absorbed dose area, however, the inclination of the curve became small caused by the increase in dose. And, though it can be indicated to digital value 256 with digitized image of 8bit, the calibration curve for NIH-image software was saturated with about digital value 200.

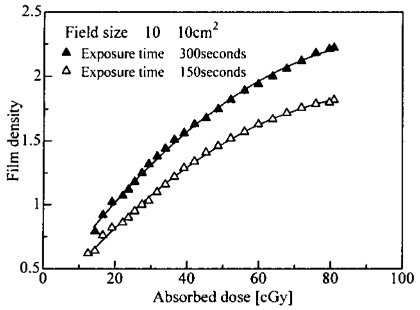

Figure 4. Calibration curve for Isodose plotter (Film density distribution)

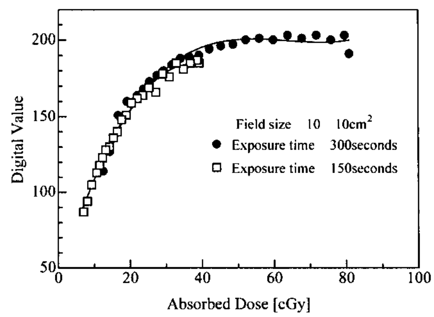

Figure 5. Calibration curve for NIH-image (Digital value distribution)

4. DISCUSSION

From the fact that while film density distribution (Figure 4) showed a good linear increase with high-absorbed dose area, digital value distribution (Figure 5) was saturated with about digital value 200, we can suggest that the film density wasn't converted correctly into the digital value in high-absorbed dose area, that is high film density area. With this influence, in high-absorbed dose area, a change of the digital value that was dependent on absorbed dose didn't appear. From this reason, each isodose curves couldn't be separated with a result by NIH-image software in high-absorbed dose area. The viewpoint that film density wasn't converted correctly into digital value in high-absorbed dose area, also helps account for the result that isodose curve of 120seconds exposure could separate to higher dose range than that of 300seconds exposure. The film density of the sample of 120seconds exposure was lower than that of sample of 300seconds. From this reason, with a sample of 120seconds exposure, film density was converted correctly into digital value to higher dose range than a sample of 300seconds exposure. This influence brought a difference between isodose curve of 120seconds exposure and that of 300seconds exposure in limit of range that it could separate isodose curve. Taking the defect of a conversion of the film density to the digital value into consideration, the saturation region of the calibration curve for NIH-image software (digital value distribution) has a possibility that the curve shows the data that is different from the original data of film. So, it can be considered that an error was brought between isodose curve by Isodose plotter and that of NIH-image software because isodose curve was drawn using this wrong data. The future direction of this study will be that to improve a saturation of calibration curve, we need to examine to the conversion of the film density to the digital value in the high-absorbed dose area, that is, the high film density area. If this problem will be improved, precision of isodose curve using NIH-image software will be raised, and this method will be a convenient system that can be used handily at a low cost.

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