TLD Correction Factor for Dose Delivery Verification on Gamma Radiation Cobalt-60 on Clinical Treatment

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***Abstract*—In vivo dosimetry is the best way to confirm accuracy of delivered to the patient. Proper calibration of TLD prior in vivo measurement required to ensure accurate dose measurement. TLD100 calibration were done using Alcyon cobalt60 teletherapy machine using SSD technique on water phantom. Series of doses from 10cGy to 400cGy delivered to determined TLD response over dose variation and calibration factor. Cobalt 60 radiation output calibration was measured to determined irradiation time. TLD's were placed on phantom surface and in water at 5cm depth using 10cm X 10cm field size, and read using Harshaw Model 2000A and 2000B TLD reader. Depth of maximum was selected as TLD dosimetry reference point, and calibration factor and curve were made based on dose at dmax position. To study TLD response with field size changes, the TLD were irradiated with several field sizes. Measurements showed different result between two calibration methods. On surface calibration over series of doses giving linier function of y = 85.732x – 1.874 and in phantom measurements giving linier function of y = 52.388x + 14.749. The calibration factor for on surface and in phantom are 84.365 cGy/μC and 57.158 cGy/μC. TLD show high response at 4cm x 4cm field size and show decreasing trend as field size increases. Calibration should be done according to in-vivo measurement setup that will employ at the institute. It is clearly seen that the two different setup gave greatly different results. Surface calibration suitable for dose estimation using entrance dose measurement setup. In phantom calibration only suitable for dose determination that uses TLD within phantom, such as IMRT dose verification using TLD or organ dose study, and it is important to correct the TLD response with field size changes.**

Keywords— **TLD100, calibration, cobalt 60, in vivo.**

I. Introduction

Radiotherapy treatment delivery is complex systems. The processes involve multidiscipline knowledge and many personnel. There are possibilities for each process introducing error which leads to changes of planned and delivered dose. In external beam therapy, quality assurance program is carried out for each process and many protocols give recommendation on tolerance level in order to reduce error on treatment delivery. Even though all the quality assurance was done on every process, the best quality assurance is at the end of the treatment process. At this point, user can detect if the planning is not match with delivering. In vivo dosimetry can measured dose at target volume indirectly.

Several methods for in vivo measurements are available such as TLD, MOSFET and diodes[1-5]. Prior in vivo measurement, proper calibration is required to ensure accuracy of the measurement. TLD are commonly use for special procedure and for patient it seems more comfortable since no cable and electrometer required during measurement, but TLD is more labor intensive. Diode and MOSFET are more convenient to use since it gives online reading during measurement instead of TLD which required read out after measurement, but diode and MOSFET less convenient for patient since it uses cable attach to it. Even though TLD system is more expensive and required more labor than diode and MOSFET, the application of TLD for in vivo is still popular. TLD has wide dose range and can be used for long term and proper calibration is very important when using TLD.

In vivo measurement can be done using surface dose or in-phantom method and proper calibration factor is required for each measurement method. Medical physics laboratory at Dosimetry division of Centre for Technology for Radiation Safety and Measurement is trying to improve its capability by making a methodology to monitor dose delivered to patient using in vivo measurement with TLD. This work studies the effect of calibration setup for TLD and its response with field sizes change.

II. Material and methods

Measurement were done using TLD100 chip, TLD reader model 2000A and B from Harshaw, and Cobalt 60 teletherapy machine Alcyon II at Dr. M. Jamil hospital Padang West Sumatra. Batching procedure before measurement were done to ensure TLD chips used on measurement has same response and to reduce reading variation during measurements. Three TLDs were used for each point of measurement; this technique was used to control TLD reading consistency. If reading variation between those three TLD were > 5%, the closest reading in that TLD group will selected. Cobalt 60 output calibration was done

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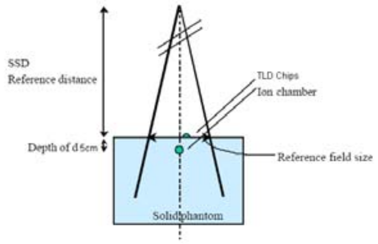
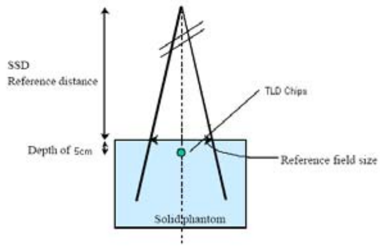
using 6cc Ionization chamber from victoreen using water phantom following TRS277 protocol with SSD 80 cm.

Dose variations for TLD calibration on phantom surface were from 7 - 315 cGy at 5cm or 10-400cGy at dmax, and for in-phantom calibration dose variation were 48 - 339 cGy at 5cm depth. The measurement setup is following standard setup for output calibration at IAEA TRS277, which is Field size 10 cm x 10 cm and dose determined at 5cm depth



(a)



(b)

Fig. 1 (a) Measurement setup for on-surface and (b) in phantom calibration using reference field size = 10 cm x 10 cm

Calibration factor are obtained by taking ratio of dose of ionization chamber and TLD reading at reference conditions[5] (equation 1 and 2). Since measurements are done at 5 cm, PDD correction required to correct measured dose to d_{max} position. TLD reading at 5 cm is corrected to dmax position using PDD table as well as dose correction from 5 cm to dmax position.

$$F_{cal} = \left(\frac{D_{IC}}{TLD_R} \right) \tag{1}$$

$$D(d_{\max}) = \left(\frac{D(5cm)}{PDD(5cm)} \right) \tag{2}$$

D_{IC} is dose from ionization chamber measurement and TLD_R is TLD reading. Using this ratio the TLD reading will be corrected into absorbed dose at reference depth.

There was no build up use for on-surface measurement; this technique was use because it seems more practical for clinical use. In-phantom measurements were done using water phantom at 5cm, and same equation was used to determine calibration factor. From this measurement we can obtain calibration factor at 5cm for TLD exactly as defined by equation 1. Dose response of TLD with dose variation can be seen by creating plotting the TLD reading and actual dose. It is expected TLD has a linier response, and some extra correction will required if the curve is not linier. Reference point selected for TLD calibration factor is at dmax position since it is simpler than selecting at any other depth, at dmax the PDD will always 100% and it would be easier to understand how to move the calibration point at any depth. Correction factor for field size variation were calculated using equation 3 and 4[5], and the setup configuration is following fig.1a

$$CF_{FS} = \frac{OF_{IC}(c)}{OF_{TLD}(c)} \tag{3}$$

$$OF(c) = \frac{R(c)}{R(10cm)} \tag{4}$$

Where c is side of the square field in cm, and R is detector reading.

III. RESULT AND DISCUSSION

Table 1 and 2 shows that two measurement setups are giving different result. Calibration factor from on surface setup can be derived into any depth as long as the output calibration using ionization chamber is done properly, and it can be calculated using PDD table. Value of calibration factor at 5cm on both setups is different; this might happen because there is more scatter inside the phantom compare on the surface. The variation of calibration factor is 2.741% and 6.025% for on surface and in phantom methods as shown in fig. 2. It shows that measurement in phantom surface is giving less variation compare with in phantom measurement setup. The standard deviation is constant for dmax and 5 cm because PDD correction factor used to correct dose at 5cm to dmax is canceling out in standard deviation calculation.

Dose response of TLD are linier on both measurement setups with R^2=0.9984 and R^2=0.9963 for surface and in phantom setups. The linier equation are y=85.73x-1.87 and y=52.39x+14.75 for on surface and in phantom setup using dmax as reference point, and when 5cm depth uses as reference the linier equations are y=67.56x-1.48 and y=52.39+11.62 for on surface and in phantom setup. The different between two reference point is due to PDD correction when converting dose point from measurement to reference point. When in vivo dosimetry use surface dose