A Study of Measurement of Relative Dose With Various Chamber for Small Field Dosimetry of 6 MV Photon Beam

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Abstract

The new technologies intensity modulated radio therapy (IMRT), image guided radio therapy (IGRT) and stereotactic radio therapy (SRT) are the improved radiotherapy techniques where proper commissioning of Clinac is necessary to save patient's healthy cells from adverse effect of radiation. The IAEA dosimetry protocol TRS-398 has been used to measure the absolute dose at 10 cm × 10 cm with CC13 (ionization) chamber. Later, the CC13 chamber was cross calibrated with CC01 (Ionization) and Razor (diode) chamber respectively for the measurement of dose in small fields. According Daisy Chaining Factor method, dose was measured for CC13 (ionization) to Razor (diode). On the other hand, the reference dose for small field was also measured for different field size(s) by applying newly proposed formalism (R. Alfonso *et al.* 2008) using CC13 (ionization) chamber and fitted with 4th order polynomial fitting function where $R^2=1$. The variation of dose was observed as around ±4% by CC01 (ionization) and Razor (diode) chambers for field sizes 1 cm × 1 cm field at reference condition in the cross-calibration technique. The sources uncertainties were calculated as per IAEA guidelines for both Type-A and Type-B. The combined standard uncertainty lies within ±1.51% (1σ).

Keywords: Intensity modulated radiotherapy, image guided radiotherapy, stereotactic radiotherapy, technical report series, source to surface distance

1. Introduction

The small irradiation field (Bragg Gray cavity theory does not exit due to lack of charged particle equilibrium) is frequently used in modern radiotherapy techniques in a stage of commissioning of Clinac for Intensity Modulated Radiotherapy (IMRT), Image Guided Radiotherapy (IGRT), Stereotactic Radio surgery (SRS) or Stereotactic Radiotherapy (SRT) techniques to save patient's healthy cells from adverse effect of excessive radiation [1]. Dosimetry for treatment planning system for small fields is a great challenge in radiotherapy are such as i) some machine does not suitable for maintaining the protocol of proper dose distributions and ii) protocols for small field is still in the process of scientific research [2]. Small field radiation is not properly standardize due to i) volume averaging effect of ionization chamber in small field, ii) focal spot difficulties and iii) source occlusion effect (overlapping of penumbra effect) [1, 2]. Varieties of detection instruments such as ionization chambers, solid state diodes, thermos-luminescence dosimeters and films are generally used for small field dosimetry. Paskalev*et al.* [3] revealed in their work that 0.2 mm misplacement in 1.5mm diameter radiation field resulted 5% variation of distortions in percentage of depth dose calculations. According to Mckerracher and Thwaites [4], no single chamber was ideal for the measurement of all types of dosimetric parameters. Diode chambers having extremely small measurement volume and good sensitivity towards escalated low energy dose with proper placement are employing for measurement techniques. In this research, we have measured relative dose of small fields for 6 MV photon beam delivered from Varian Clinacix 5982 using CC13 (ionization intermediate size) and Razor (diode) chamber with the help of some techniques published in the literature for small field dosimetry. Finally, the correction factors for Razor (diode) chambers is obtained by using CC13 (ionization) chamber from fitted curve.

2. Materials and Methods

According to the IAEA TRS-398 [5] protocol, the dose for reference field (10 cm × 10 cm) was measured with CC13 (ionization) chamber and compared with the relative dose measured by various approximation method as well as with newly proposed formalism [6]. A Varian Clinac ix-5982 electron accelerator capable to deliver 6 MV photon beams that was used in our present measurement. The CC13 is a medium sized ionization chamber having 0.13 cm^3 measurement volume with C552 central electrode material having proper water proofing. On the other hand CC01 has 0.01 cm^3 small measurement volume with steel central electrode material including proper water proofing. The Razor (diode) having extremely small active volume consists of 4.1 nC/Gy sensitivity for ^{60}Co beam based on p-type rigid and long lasting silicon diode chip placed in the water phantom toward parallel direction in delivering beam. Ionization chambers were placed in water phantom at 100 cm SSD, 10 cm depth towards perpendicular to the direction of the delivering photon beam. Dose-1 (IBA manufacturer) electrometer used for measuring of charge in unit of Coulomb with proper accuracy. In the present work, we used IBA echo water phantom (484841), having three echo sensors on its X-, Y-, and Z axis. A common control unit is integrated with the phantom that acts as an interface

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