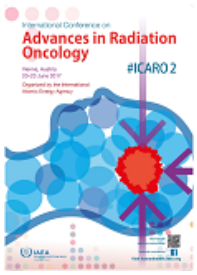

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A novel technique for postal intercomparison of beam Quality Assurance criterion of Proton Therapy facilities using radiochromic film EBT3

Wednesday, 21 June 2017 15:40 (5 minutes)

Introduction:
Validation of therapeutic proton field bases on daily quality assurance (QA) procedure is imperative to routine proton therapy. The ratio of delivered and measured proton dose at the reference point under "standard condition"is defined as primary QA criterion. The standard condition (R20M10) is characterized as follows: (a) proton beam energy corresponding to a range (R) of 20 cm in water, (b) beam modulation (M) depth, known as spread out Bragg Peak (SOBP) of 10 cm, (c) Field size of 10 cm x 10 cm, (d) Air-gap of 20 cm, (e) dosimetry point (reference) located at the center of the SOBP and (f) proton dose of 2 Gy delivered in a single fraction using uniform scanning (US) mode. The proton dose under standard condition in a water or polystyrene pate phantom are commonly evaluated using various active devices, including Flat plate ionization chamber (FPIC), Multi layer ionisation chamber (MLIC) or a compact QA dosimetry device (Model: QA3; Manufacturer: Sun Nuclear Corp., Florida, USA). At WPE/IBA Group in Essen, Germany we have developed a passive method of proton dosimetry under standard condition using radiochromic film (Model: EBT3; Manufacturer: International Speciality Product, Wayne, USA). A handheld optical densitometer (Model: Unilight D; Manufacturer: IBA Dosimetry, Schwrzenbrück, Germany) was used for film readout purpose. The technique does not require and active electrical power hence, ideally suited for inter-facility proton beam QA inter-comparison studies.

Methods:
We cut out six sections (8cm x 8cm) from a standard sheet (25cm x 10cm) of Gafchromic EBT3 film using a pair of sharp scissors. The sensitivity of EBT3 films depends on their orientations i.e. Landscape (LSC) or Portrait (POR) mode. In order to compensate this effect we stacked two film sections with LSC and POR orientations at right angles (90o) to each other. We have prepared six batches EBT3 dosimeter each incorporating three stacks. Five dosimeter batches were mailed to five proton therapy centres in Europe and USA operating PROTEUS Plus and PROTEUS One Medical Cyclotrons of IBA. The 6th batch was exposed under standard conditions at WPE as benchmark. The beam Quality Assurance Criterion (QAC) is defined as the ratio of net (background subtracted) optical density (NOD) of the 1st film stack exposed to a proton dose of 2Gy at the Proton Therapy Centre of interest (NODx) and the NOD of the 2nd film stack of the same batch exposed to a proton dose of 2Gy at WPE (NODwpe**strong text**) under standard condition. The optical density (OD) of the 3rd film stack (control) was used for background subtraction:

QAC = (NODx/NODwpe)2Gy (1)

Results:
We have duly received the samples exposed to protons under standard conditions from ProCure Proton Therapy Center (PCPTC), Oklahoma City, USA operating a PROTEUS Plus cyclotron like ours at WPE. The delivery of exposed film samples from four PT centres are still pending. The NOD was evaluated at three spots in the central zone of the films using IBA Unilight D densitometer. The QAC was calculated using equation 1. Results are depicted in Figure 1.

Conclusion:
We have developed a robust and simple method for postal intercomparison of quality assurance criterion of proton therapy facilities. The method is based on radiochromic films widely used by medical physics fraternity. The inherent shortcomings of radiochromic films namely, orientation dependence of sensitivity and batch inhomogeneity were resolved. The usage of TLD has the pitfalls like fading, complex evaluation routine

and requirements of expensive TLD reader and annealing oven. Our method outperforms the postal dose intercomparison studies using TLD. A worldwide implementation of this novel technique in commercial basis is envisaged.

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