A dosimetry intercomparison Phantom for intraOperative RadioTherapy (iPORT)

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Background

Good practice requires the quantification of dose delivered to patients during radiation therapy and the implementation of suitable quality assurance programs [1]. We used four Zeiss Intrabeam™ low kV x-ray sources (XRS) to treat breast and brain tumours [2]. Extensive measurements have been made on each source and this functional intercomparison showed that all four sources have similar performance characteristics [3]. It was proposed to extend this intercomparison to include XRS at all centres participating in the TARGIT breast cancer trial [4]. In this work, we present a cylindrical PMMA dosimetry **i**ntercomparison **P**hantom for intra**O**perative **R**adio**T**herapy (iPORT).

Methods

The iPORT was used with Gafchromic XR Type R film (GC-XRR) to determine absorbed dose at a fixed prescription depth for four XRS. The iPORT has two advantages over a water phantom. Firstly, the iPORT is more convenient for routine use than a water phantom. Secondly, the sensitive Beryllium-coated probe of the XRS does not need to be immersed in water for long periods.

Figure 1 shows the iPORT. The PMMA cylinder is 35 mm in diameter and 166 mm in length with 2 concentric rings of 4 ventilation holes. The proximal end of the phantom is open and the distal end is closed by a removable PMMA cap 8 mm thick at its centre. The internal diameter at the proximal end is 25.5 mm and is designed to fit over the interlock. The internal diameter at the distal end is 20 mm and accommodates the cap. The iPORT slides over the interlock made of stainless steel with a milled base.

We investigated the cross- and down-web uniformity and the energy response of GC-XRR film at energies between 30 and 50 kVp. Measurements were performed in a water phantom with the film placed 10 mm away from the probe tip. We also assessed the variation in net density and absorbed dose for each XRS. A comprehensive error assessment was also undertaken.

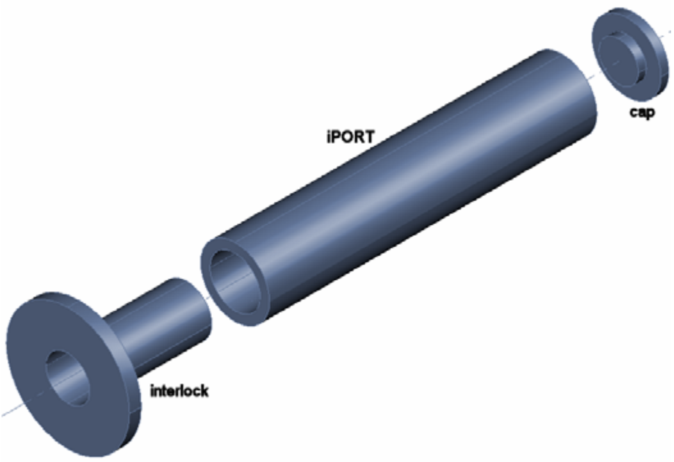

Figure 1: Assembly of interlock, iPORT and PMMA cap

Results

We found the iPORT phantom robust and easy to use. The film uniformity in the cross-web direction was 1.42% and 1.46% in the down-web direction. For 50 kV x-rays, the mean difference in net density among the XRS was 1.29%. The corresponding differences for 40 kV and 30 kV were 1.43% and 0.88%, demonstrating the similarity in performance characteristics of the XRS.

Each of four different XRS was used to evaluate the iPORT phantom. Among the four XRS tested, the spread in net density was found to be ± 1.9%. The spread in absorbed dose was found to be ± 3.9%. The overall uncertainty using the iPORT to measure absorbed dose at 10 mm from the probe tip was found to be 4.72%,

Conclusions

We propose that the iPORT phantom, used in conjunction with an interlock and GC-XRR film, is a viable dosimetry intercomparison system for Intrabeam™ x-ray sources.

References

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