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Film Dosimetry Using a Newly Invented Phantom

Inhwan J Yeo, Chris Wang[1], Sandra Burch[2]

Radiation Onc. Samsung Medical Ctr. Seoul Korea, [1]Georgia Inst. Tech. Georgia USA, [2]Medical College of Georgia, Georgia USA

INTRODUCTION

Successful radiotherapy relies on accurate dose measurement. Traditional dosimeters such as ion chambers, TLD, and diodes spend up relatively long time for multidimensional measurement of photon beams (static and dynamic). X-ray film, an integrating dosimeter, is not associated with such a problem. However, x-ray film is known to overrespond to low-energy photons (energies less than 400 keV), abundant at deep parts of a phantom, and thus generates unacceptably inaccurate dosimetric data.

METHOD

To solve the above problem, this paper introduces a new phantom. The phantom was fabricated from base material of polymer resin, mixed gradually with lead powder. The lead-to-resin ratio was determined by Monte Carlo simulation of photon transport in the water-equivalent media in which x-ray film was placed in such a way to measure depth dose and beam profiles. The result of the simulation is shown in figure 1. The film dose to tissue dose ratio flattened as the addition of lead increased. Note that without addition of lead, the film dose greatly overesponds compared with the tissue dose and the degree of overresponse is most significant at about 30 cm depth in a water phantom. The role of lead was to filter out low-energy photons and keep them from entering the film. The phantom fabricated in this study was extensively tested for various beam energies.

RESULTS

The test result indicates that in-phantom dose distributions based on the x-ray film and the new phantom agree well with those measured by ion chambers for various beam energies. Figure 2 shows the measured data for 4 MV photon beam.

DISCUSSION

The amount of overresponse in film dosimetry is known to be depth dependent. Thus, the amount of added lead should vary with depth. However, uniform addition of lead worked reasonably. We believe this is because lead selectively absorbed low-energy photons, which causes overresponse.

CONCLUSION

The phantom was a success. As a further study, the phantom should be tested for mechanical strength and possibility of other applications.

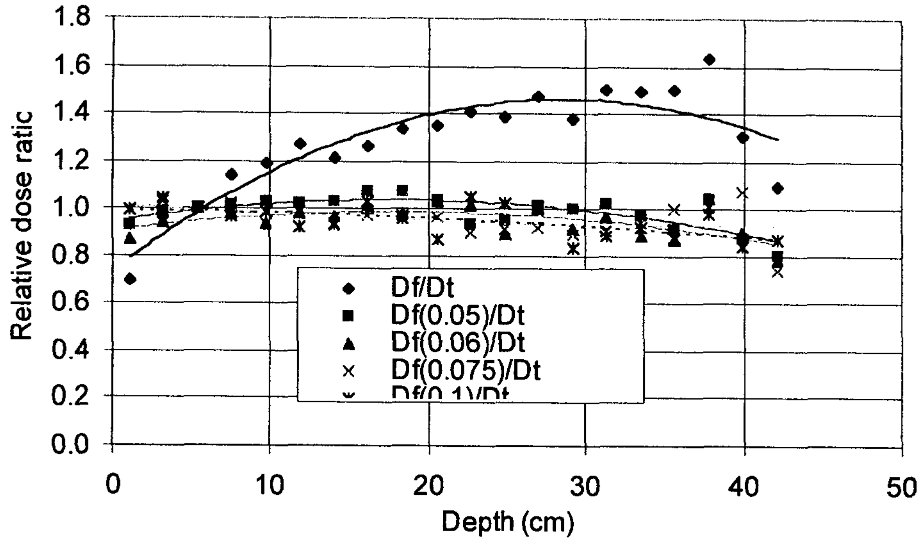

Figure 1. The trend of film depth dose (Df) to tissue depth dose (Dt) ratio as the weight percent of lead (in the parenthesis) increases.

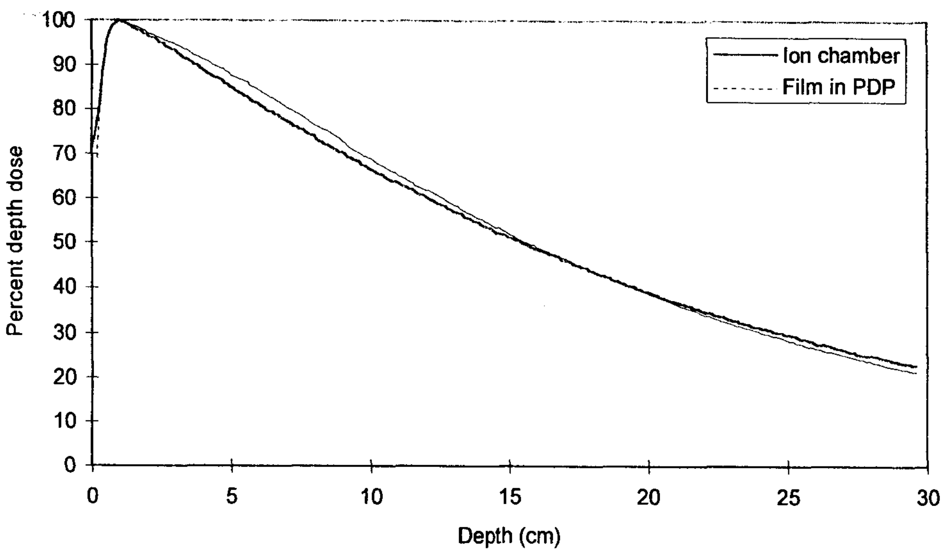

Figure 2. Depth-dose distribution of the x-ray film exposed in the leaded phantom compared with ion-chamber measurement for the 4 MV beam with a 25 cm x 25 cm field.