An evaluation of out-of-field doses for electron beam applicators on Varian and Elekta linear accelerators

Carlos Cardenas, Paige Nitsch, Rajat Kudchadker, Rebecca Howell, Stephen Kry[1]

[1] Department of Radiation Physics, The University of Texas M.D. Anderson Cancer Center, Houston, TX

THE UNIVERSITY OF TEXAS MD Anderson Cancer Center

Introduction

Accurately determining out-of-field doses when using electron beam radiotherapy is of importance when treating pregnant patients or patients with implanted electronic devices. Scattered doses outside of the applicator field in electron beams have not been broadly investigated, especially since manufacturers have taken different approaches in applicator designs.

Methods

In this study, doses outside of the applicator field were measured for electron beams produced by a 10x10 applicator on two Varian 21iXs operating at 6, 9, 12, 16, and 20 MeV, a Varian TrueBeam operating at 6, 9, 12, 16, and 20 MeV, and an Elekta Versa HD operating at 6, 9, 12 and 15 MeV. Peripheral dose profiles and percent depth doses were measured in a Wellhofer water phantom at 100 cm SSD with a Farmer ion chamber. Doses were compared to peripheral photon doses from AAPM's Task Group #36 report.

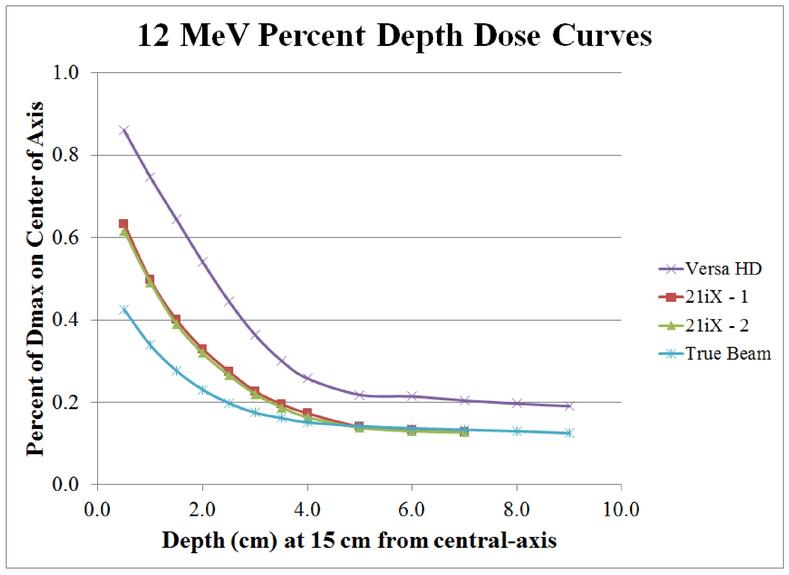

Figure 1. Difference in percent depth doses between different linear accelerators for 10x10 cm applicator for a 12 MeV electron beam. Measurements were made at a constant distance 10 cm from field edge while increasing depth in water. PDD values were normalized to the central axis Dmax value.

Results

Doses were highest for the higher energies. When comparing all linear accelerators involved, Elekta Versa HD had the highest out-of-field doses for all energies. At distances greater than 20 cm from central-axis, it was observed that doses for the Versa HD exceeded the photon doses from data published in AAPM's Task Group 36. The lowest doses were recorded for Varian's TrueBeam accelerator. All Varian linear accelerators showed doses below TG 36's values. Doses decreased sharply with depth until reaching the bremsstrahlung background. Doses were found to decrease to an approximate depth of E(MeV)/4 in cm.

Innovations/Impacts

Out-of-field dose data for linear accelerators using electron beam mode are largely unknown. This study shows we need to pay special attention to out-of-field dose levels for electron beam radiotherapy, but also provides practical management guidance.

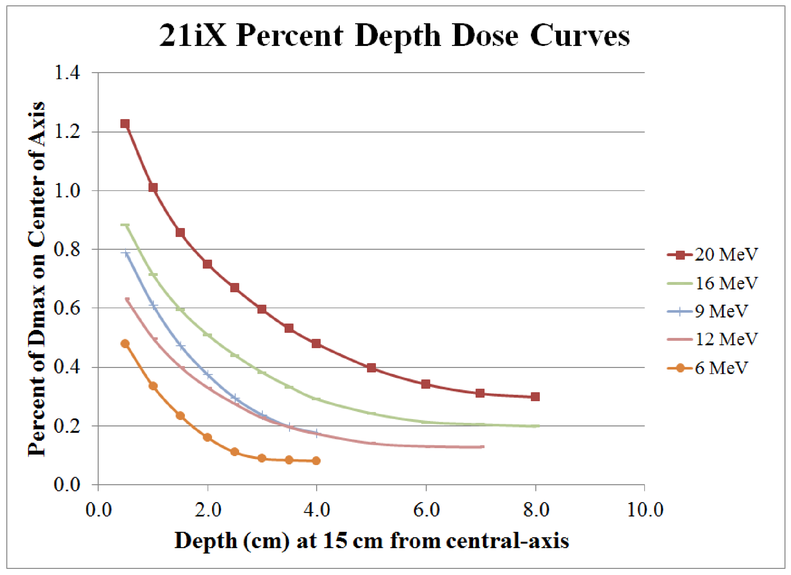

Figure 2. Percent depth doses for Varian 21iX for a 10x10 cm applicator. Measurements were made at a constant distance 10 cm from field edge while increasing depth in water. PDD values were normalized to the central axis Dmax value.

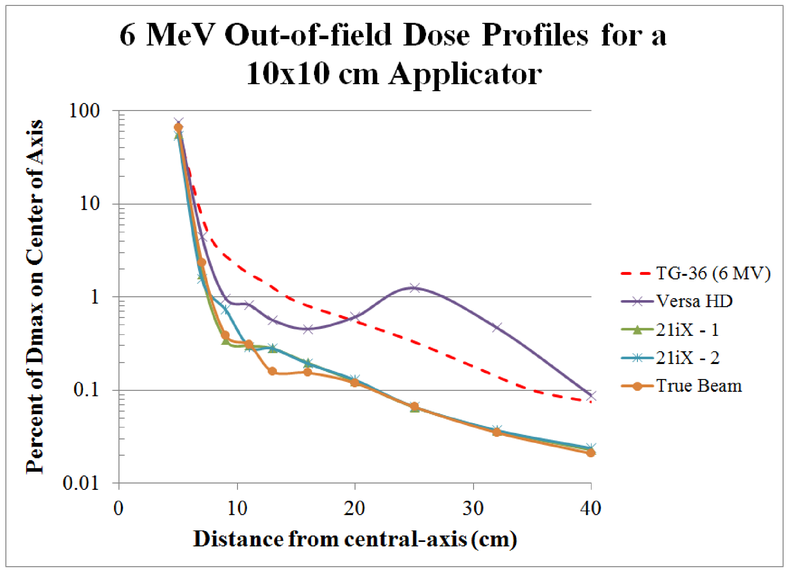

Figure 3. Difference in out-of-field doses between different linear accelerators for 10x10 cm applicator utilizing a 6 MV electron beam. Measurements were made at a constant depth, Dmax, while changing distance from central-axis. For comparison, TG-36 6MV photon data is also included.

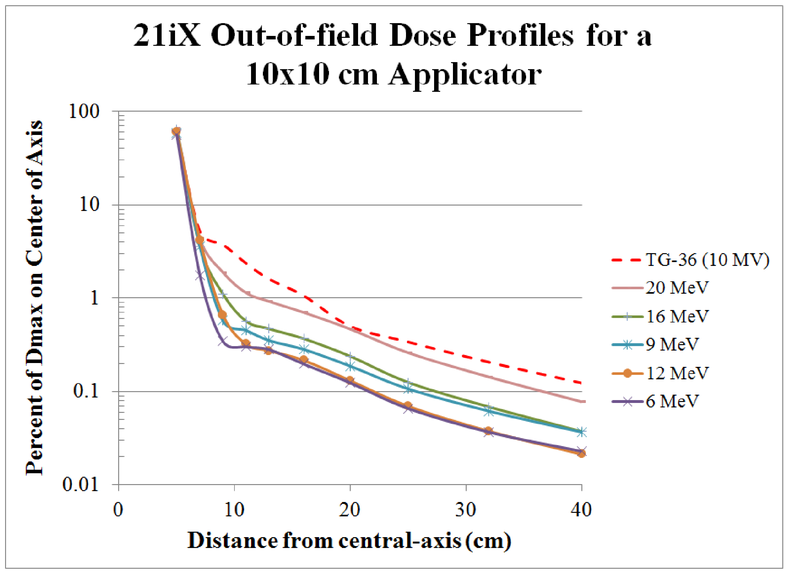

Figure 4. Difference in of out-of-field doses and electron beam energy for Varian 21iX utilizing a 10x10 cm applicator. Measurements were made at a constant depth, Dmax, while changing distance from central-axis. For comparison, TG-36 10 MV photon data is also included.

Conclusion

The results of this study indicate that proper shielding may be very important when utilizing electron beams, particularly on a Versa HD, while treating pregnant patients or those with implanted electronic devices. Applying a water equivalent bolus of E_{max}(MeV)/4 thickness (cm) on the patient would reduce fetal dose drastically for all clinical energies and is a practical solution to manage the potentially high peripheral doses seen from modern electron beams.