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Dosimetry Characteristics of Small Field Cones for Intracavitary Radiotherapy

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INTRODUCTION

A high energy linear accelerator(CLINAC) has been designed exclusively of electron cones for intracavitary radiotherapy. We have designed the intracavitary cones which were made of stainless-steel and have scretched inside cone to be generated electron scatter and designed to be attached easily to the linac collimator and controlled cones length to be contacted smoothly between the patient and the cone tip. Dosimetry measurements were made to commission the linac for 6 - 20 MeV electron using the intracavitary cones. Two types of intracavitary cones are used. One is the straight end cones with circular opening on the distal end and the other is 30 degree beveled end cones with elliptical opening on the distal end. Each type of intracavitary cone ranged in daimeter from 2.5 cm to 3.5 cm and required a separate set of lower trimmer annulias cone diameter. The aim of this paper is to present the data to necessary for clinical use of the intracavitary radiotherapy with electron cones. Dosimetric measurements were made to allow the calculation of the monitor setting for delivering a prescribed dose at any depth for any irradiation condition. Isodose curves were measureed for all energy and cones combinations. The characteristics of the isodose data that were analyzed for clinical use included. the depth to the 90 percent dose and the geometric coverage of the treatment volume.

METHOD

High energy electrons were generated by a linear accelerator (Varian CLINAC 2100C/D) which was not suplied the intracavitary cones and we designed intracavitary cones and atechible trimmer on linac collimator with aluminium plate and stainless steel pipes. The film phantom was designed with an internal cassette that accurately aligned the film edge with the film phantom surface and ensured the film was sealed from light. Film optical density data were subsequently measured by photodensitometer(Welhoffer 700i) The optical density was measured in the range below a gross optical density of 2.0. Within this rante, dose was linearly proportional to net optical density was obtained by subtracting a background value from the gross optical density measured by the densitometer. The film background was determined by forcing the x-ray contamination tail at the depth 2cm beyond the range to the 10% dose to equal that measured using ion chamber dosimetry. The top surface of the film phantom as set to a 100cm source to surface distance, and the film was orientated to the contain the conical central axis. For consistency, each film was irradiated perpendicular to the bend plane of the 270o which was required for beveled cone measurements made in the plane containing the cones major elliptical axis. Film was developed with an automatic processor and was scanned using the video camera system. Output is defined as the maximum dose per MU along the clinical central axis in water at 100 cm SSD. Calibration output, defined to be the output for the 15cm diameter straight cone, was adjusted to 1.00 cGy/MU-1 at each energy according to the TG-21 protocol. A calibrated 0.6 cm3 ionization chamber and electrometer were used for this procedure. Cone output factors are defined as the ratio of output for the cone of interest to the output for the 15 cm straight cone. The output factors or all cone were measued by scanning the 0.1cm3 ionization chamber in water along the clinical central axis to find dmax. At the dmax position, charge was collected for a fixed number of monitor units and converted to dose. This dose output was then divided by the dose output for the 15cm straight cone at the same energy.

RESULTS

The percent depth doses along the clinical central axis as a function of energy for the 2.5 - 3.5 cm diameter straight and beveled cones are plotted. The depth to the 80%, 50%, and 10% depth doses of 3cm cone for 12MeV energy electron is 3.1, 3.6 and 5.4 cm respectively. At all energies and field sizes the depths measured along the clinical axis to selected doses were generally less for beveled cones than those for straight cones.

Isodose curves of beveled and straight cones for the 6 - 20 MeV electron beams have been plotted with film dosimetry. A measure of bean effectiveness is th e fraction of the area defined by R80 and the geometric field edge, which contains dose greater then 80%. This fraction is less than, but near unity, with only small volumes near the geometric field edge at R80 having a dose less than 80%. Isodose volumes exceeding 100% tended to intensify with increase in cone diamerer and energy. No excessive dise horns that are greater than 100% were observed for the 3cm straight and beveled cones at energies less than or equal to 12MeV. The high dose values are due to electrons scattered off the inside cone wall and could not have been eliminated without reducing the volume enclosed by the 90% isodose curve. The cone output was a function of two components that contributed to central axis dose the fluence of primary electrons and the fluence of electrons scattered from the inside walls of the treatment cone .Output factors as a function of cone size for the five nominal energies are measured for straight and beveled cones. Straight cone output factors range from 0.175 to 0.856, and beveled cone output factors range from 0.153 to 0.843. One observes a peak in the output in the vicinity of the cones at all energies, this peak is believed to be due to the number of electrons scattered from the inside walls. The number of scattered electrons increases with cone diameter due to an increased solid angle subtended by the inner surface of the cone.

CONCLUSION

The depth dose along the central axis depended on the cone bevel angle, as well as , beam energy and cone size. At the same incident energy Ep0, the range to the 80% dose was slightly increased and had steeper depth dose gradient and photon contamination was less for the large field. The geometric coverage of the 80% isodose curves varied as a function of electron energy ,treatment cone size and cone type. Cone output factors were a function of energy, cone size and cone type. Air gap corrections for the metallic treatment cones used with the intracavitary cone differed from those determined using conventional external bean cones. Properties of the isodose plots cone output and air gap correction factors were qualitatively explained by a complex dependence of cone wall scatter on cone size energy and geometry.