CHARACTERISTICS OF CLINICAL ELECTRON BEAMS IN RADIATION THERAPY

A PROJECT REPORT PRESENTED BY

S.N.C.W.M.P.S.K. HULUGALLE

to the Board of Study in Physics of the

POSTGRADUATE INSTITUE OF SCIENCE

in partial fulfilment of the requirement

for the award of the degree of

MASTER OF SCIENCE IN MEDICAL PHYSICS

of the

UNIVERSITY OF PERADENIYA

SRI LANKA

2011

ABSTRACT

CHARACTERISTICS OF CLINICAL ELECTRON BEAMS IN RADIATION THERAPY

S.N.C.W.M.P.S.K. Hulugalle

PGIS

University of Peradeniya

Sri Lanka

High energy electron beams are widely used in the treatment of tumors which are located upto about 6 cm from the skin surface. High surface dose, relatively long range of mega electron beam in tissue and rapid dose falling off behavior make possible to deliver uniform dose from the skin up to a certain depth and spare the critical structures immediately beyond. In view of electron beam characterization, central axis percentage depth dose, Inline and Crossline profiles, symmetry, flatness, penumbra, X-ray contamination, R_{100}, therapeutic range, practical range have studied and compared at nominal and extended SSDs for various energies of 6, 9, 12, 16 and 20 MeV. Virtual SSD has been calculated for all standard cones and outputs in nominal and different extended SSDs have been taken for different cutouts and cones. Cone factors, cut-out factors and the gap factors were calculated and studied the variation of those factors with the energy and the SSD. The measurements were carried out with the major dosimetric tools such as blue phantom with 0.125 cc chamber, parallel plate chamber and electrometer. The variations are found in the beam characteristics with open and shielded cones and also with nominal and extended SSDs. If the size of the cutout is less than the half of the standard cone size then the surface dose for the cutout will be greater than the open applicator. This is more prominent in lower energies creating at least the difference of 10% and also surface dose increases with extended SSD. X-ray contamination rises from 0.4-4.7% between 6 to 20 MeV. The values of R_{100} increases for energies from 6 to 12 MeV and beyond that it decreases. R_p is mainly dependent on energy and no significant variation is noticed for varying SSDs and different cutout sizes. The flatness of the beam for all the standard applicators and cutouts made of cerrobend becomes poor

in the extended treatment distance and also narrows the beam profile. This constriction is within the useful beam area (R_{100}-R_{80}) which may cause non-uniform coverage and under-dosage of the lateral tissue. Thus, in clinical situations at extended treatment distance, the field margin should be enlarged for adequate lateral coverage. Penumbra increases with the increase of SSD and the rate of increase reduces from 6 MeV to 20 MeV. This may cause difficulties in generating a suitable dose distribution and it is recommended that the distance from the applicator to the surface to be as low as possible. Cone factor is less for small cones and high energies. Gap factor is inversely proportional to SSD and also decreases with the increasing energy. VSSD varies with applicator size and energy. In general, electron beam characteristics at extended distances are dependent on the machine design and type of collimation. This study will increase the efficiency by eliminating the need for patient specific dosimetry measurements and also facilitate the clinical use of electron beams for the accurate dose delivery in the treatment.