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Surface Dose Measurements on Indigenously Made Female Pelvic Phantom Using MOSFET Dosimetric System and Pinpoint Ionization Chamber

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ABSTRACT Surface radiation dose measurements on an indigenously made inhomogeneous female pelvic phantom are carried out using MOSFET dosimetric system and pinpoint ionization chamber. The small measuring volume is advantageous for surface dosimetry. The percentage dose differences are calculated at the central axis point, boundaries and outside points of the radiation field between treatment planning system (TPS) given and direct measured dose values at the pre-defined points. The percentage dose differences are found to be within 3% and 8.5% at central axis and 14.5% and 21.5% at field boundary for MOSFET dosimeter and pinpoint ionization chamber.

KEYWORDS : Inhomogeneous female pelvic phantom, MOSFET, Pinpoint Ionization Chamber. Treatment planning system, Percentage dose difference.

INTRODUCTION:

Female pelvis consists of variety of heterogeneous tissues and pelvic surface is convex in shape. High energy photon beams are used for treating the pelvic malignancies because of the skin sparing effect. [1] High energy photon beam comes out from collimator, low energy photons and electrons contaminate the beam till it reaches the surface and they lead to increase the surface dose. [2,3] The surface dose is also increased by backscatter radiation produced by high density tissues adjacent to surface and also modified by curvature. The aim of this study is to find out the effect of pelvic tissue heterogeneities and curvature on surface doses at central axis point, boundaries and outside the radiation field.

MATERIALS AND METHODS:

A MOSFET Dosimeter (Best Medical Canada make) [4,5,6,7] and a pinpoint ionization chamber with UNIDOS E Electrometer (PTW make, vented sensitive volume 0.015 cm^3) are used and dose measurements are carried out on the surface of an indigenously made female pelvic phantom (figure 1). X-rays photon beams (6 & 15 MV) are generated by Linear Accelerator (Siemens make). The CT-slices (3mm thick) of an indigenously made female pelvic phantom are taken by CT-Simulator (Somatom Motion, Siemens make) with and export to treatment planning system for generating the AP/PA radiotherapy plan in case of carcinoma cervix . A 10x10 cm^2 symmetric square field is marked on the pelvic phantom surface at a source to surface distance (SSD) of 100 cm(Figure 2) and the surface point doses are measured at central axis point (G), field boundary points (F, H) and two points (E, I), 2 cm away from the field boundaries in either sides of field.

Figure 1: Indigenously made female pelvic phantom

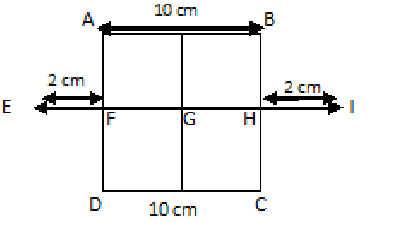

Figure 2: Square field marked on the pelvic phantom

Setup for radiation point dose measurements:

(1) 6 MV, open field
(2) 6 MV, solid tray block (acrylic) field
(3) 15 MV, open field and
(4) 15 MV, solid tray block (acrylic) field.
(5) Dose prescription is 200 cGy at d_{max} for both 6 & 15 MV.

RESULTS:

- For setup 1, the percentage dose differences at points (F, G, and H) are 14.29%, 1.69%, 9.09% and 21.29%, 8.17%, 9.1% for MOSFET dosimeter and Pinpoint ionization chamber respectively. (Table 1)
- For setup 2, the percentage dose differences at points (F, G, and H) are 9.95%, 2.83%, 9.96% and 14.66%, 5.32%, 9.86% for MOSFET dosimeter and Pinpoint ionization chamber respectively. (Table 2)
- For setup 3, the percentage dose differences at points (F, G, and H) are 14.31%, 1.41%, 12.04% and 21.29%, 7.89%, 17.57% for MOSFET dosimeter and Pinpoint ionization chamber respectively. (Table 3)
- For setup 4, the percentage dose differences at points (F, G, and H) are 8.52%, 2.89%, 12.21% and 14.28%, 5.39%, 9.89% for MOSFET dosimeter and Pinpoint ionization chamber respectively. (Table 4)

DISCUSSION:

The percentage surface dose differences in measured and computational dose values at the central axis point for open field vary up to maximum 3% for the 100 cm SSD. Butson et al. has shown that the maximum percentage skin dose deviation measured was 4% for SSDs from 80 cm to120 cm. [8] and the maximum percentage dose difference at boundaries of the field is 21.5% in solid tray block fields. Tannaus et al. has found 16% deviation in skin dose in the presence of solid block tray (0.6 cm thick) for the 10x10 cm^2 field size. [9]

The variation in direct surface dose measurements and computational dose values are due to back scatter radiation which is produced by adjacent high density tissues and curvature of the surface of the pelvic phantom. From the direct dose measurements it is also clear that dose computational algorithm used in treatment planning system does not compute the surface dose outside the field region because of its limitations. The results of this study also matched with the other studies available in the literatures. [10,11,12]

CONCLUSIONS:

High density tissues near to the surface and curvature of the pelvic region are also very prominent factors which can alter the surface doses. These two factors shall also keep in mind while generating the treatment plans.

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Table 1. Measurement setup: X-ray energy 6 MV open field, Field size 10x10 cm^2, prescribed 200 cGy dose at the D_{max} and SSD=100 cm

Surface Dosimetry using MOSFET dosimeter and Pinpoint ionization Chamber (6 MV Open Field)							
S.No.	Dose Measured Points	Measured Dose Values using MOSFET Dosimeter in Standard Bias (cGy)	Treatment Planning Computed dose Values (cGy)	% Dose Differences	Measured Dose Values using Pinpoint Ionization Chamber (cGy)	Treatment Planning Computed dose Values (cGy)	% Dose Differences
1	E	6.51	--	--	2.95	--	--
2	F	58.54	67.55	14.29	54.55	67.55	21.29
3	G	188.34	191.55	1.69	176.5	191.55	8.17
4	H	60.97	66.78	9.09	55.67	66.78	9.10
5	I	7.35	--	--	2.1	--	--

Table 2. Measurement setup: X-ray energy 15 MV open field, Field size 10x10 cm2, prescribed 200 cGy dose at the Dmax and SSD=100 cm

Surface Dosimetry using MOSFET dosimeter and Pinpoint ionization Chamber (15 MV Open Field)							
S.No.	Dose Measured Point	Measured Dose Values using MOSFET Dosimeter in Standard Bias (cGy)	Treatment Planning Computed dose Values (cGy)	% Dose Differences	Measured Dose Values using Pinpoint Ionization Chamber (cGy)	Treatment Planning Computed dose Values (cGy)	% Dose Differences
1	E	4.23	--	--	3.56	--	--
2	F	41.26	45.55	9.95	39.33	45.55	14.66
3	G	175.55	180.59	2.83	170.68	180.59	5.32
4	H	40.89	45.23	9.96	40.98	45.23	9.86
5	I	4.85	--	--	3.87	--	--

Table 3 Measurement setup: X-ray energy 6 MV with solid block tray, Field size 10x10 cm2, prescribed 200 cGy dose at the Dmax and SSD=100 cm

Surface Dosimetry using MOSFET dosimeter and Pinpoint ionization Chamber (6 MV with Block Tray)							
S.No.	Dose Measured Points	Measured Dose Values using MOSFET Dosimeter in Standard Bias (cGy)	Treatment Planning Computed dose Values (cGy)	% Dose Differences	Measured Dose Values using Pinpoint Ionization Chamber (cGy)	Treatment Planning Computed dose Values (cGy)	% Dose Differences
1	E	6.7	--	--	3.03	--	--
2	F	60.28	69.57	14.31	56.18	69.57	21.29
3	G	193.98	196.74	1.41	181.79	196.74	7.89
4	H	60.97	68.78	12.04	57.67	68.78	17.57
5	I	7.57	--	--	2.16	--	--

Table 4 Measurement setup: X-ray energy 15 MV with solid block tray, Field size 10x10 cm2, prescribed 200 cGy dose at the Dmax and SSD=100 cm

Surface Dosimetry using MOSFET dosimeter and Pinpoint ionization Chamber (15 MV with Block Tray)							
S.No.	Dose Measured Points	Measured Dose Values using MOSFET Dosimeter in Standard Bias (cGy)	Treatment Planning Computed dose Values (cGy)	% Dose Differences	Measured Dose Values using Pinpoint Ionization Chamber (cGy)	Treatment Planning Computed dose Values (cGy)	% Dose Differences
1	E	4.35	--	--	3.67	--	--
2	F	42.56	46.35	8.52	40.17	46.35	14.28
3	G	180.25	185.55	2.89	175.8	185.55	5.39
4	H	41.22	46.58	12.21	42.19	46.58	9.89
5	I	4.92	--	--	3.98	--	--

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