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Determination of absorbed dose for Mantle Field with Extended FSD.

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Abstract

Mantle field is used for supradiaphragmatic disease. Determination of absorbed dose for Mantle Field technique by conventional method and direct dosimetry is studied and compared in this paper. For Mantle field, a field size of about or more than 40 X 40cm^2 is usually needed. To obtain a bigger field size it is mandatory to extend the FSD. A change of FSD results in a significant change in Percentage Depth Dose (PDD) and beam out-put. Mayneord factor is used to determine the PDD for extended FSD. The behavior of the PDD at various FSD is studied by mathematical as well as by direct dosimetry method. The absorbed dose is obtained by performing dosimetry at extended FSD using TRS-398 protocol. From the study it is concluded that direct dosimetry is one of the precise method to determine absorbed dose for Mantle Field at Extended FSD.

INTRODUCTION

External Beam Radiotherapy (EBRT) is one of the most effective modalities for the treatment of supradiphragmatic disease. The fundamental tent of radiotherapy is to reduce the percentage error in the delivery of a prescribed dose to the tumor volume while limiting the dose to normal tissue. Mantle field is used for supradiaphragmatic disease. The target volume for a mantle field includes the occipital, submental, submandibular, anterior and posterior cervical and supraclavicular nodes. In addition it covers the infraclavicular, axillary, medial-pectoral, paratracheal and mediastinal lymph nodes. Determination of absorbed dose for Mantle Field technique by conventional method and direct dosimetry is studied and compared in this paper.

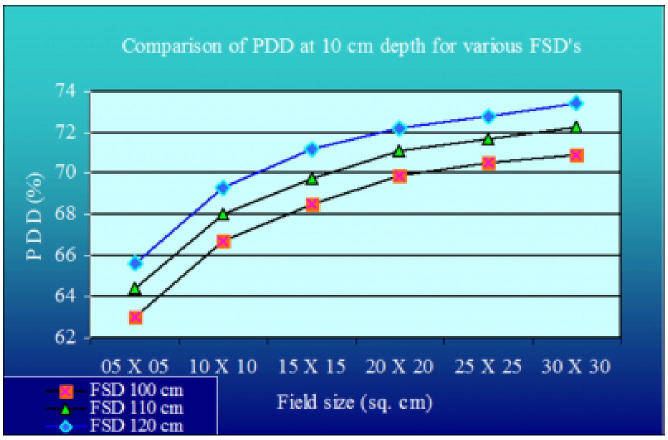
MATERIAL AND METHOD

Linear Accelerator:- Measurements were performed in a Clinac 600 C linear accelerator (Varian) which produces nominal photon energy of 6MV. The beam quality of the Linear accelerator is $TPR_{20,10}$= 0.6741, D_{10} =66.7%, d_{80}=6.5cm. The maximum possible field size at isocentre Focus to Surface Distance (FSD) equal to 100 cm is given as 40 X 40cm^2. For Mantle field, a field size of about or more than 40 X 40cm^2 is usually needed. To obtain a bigger field size it is mandatory to extend the FSD. A change of FSD results in a significant change in Percentage Depth Dose (PDD) and beam out-put.

PDD correction:- Conventionally Mayneord factor is used to determine the PDD for extended FSD. Alternatively PDD data was obtained along the central axis of the beam at various FSD of 100cm, 110cm and 120cm using 2D-Servo Radiation Field Analyzer (RFA) with 0.1cc RK cylindrical ion chamber of radius 0.2cm. The behavior of the PDD at various FSD is studied and represented in graphical form in Fig. 1.

Figure 1

Fig.1 Comparison of Percentage Depth Dose at 10 cm depth for various FSD



The PDD curve for FSD 100cm is represented in Fig.1a, similarly the PDD is also obtained for FSD 110cm and 120cm. The values are compared with the calculated values using mayneord factor.

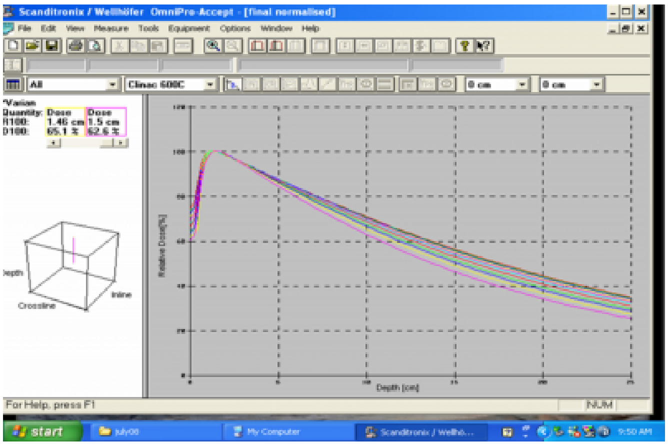
Figure 2

Table 1 : Comparison of PDD at various FSD

FSD = 100cm		FSD = 110 cm				FSD = 120 cm			
Field Size (cm^2)	PDD at 10cm (%)	Equivalent Field (cm^2)	PDD at 10cm (%) Measured	Calculated	% Error	Equivalent Field (cm^2)	PDD at 10cm (%) Measured	Calculated	% Error
05 X 05	63.00	05.5	64.4	63.88	0.81	06	65.6	64.63	1.50
10 X 10	66.70	11.0	68.0	67.63	0.55	12	69.3	68.43	1.27
15 X 15	68.00	16.5	69.7	68.95	1.09	18	71.2	69.76	2.06
20 X 20	69.90	22.0	71.1	70.88	0.31	24	72.2	71.71	0.68
25 X 25	70.50	27.5	71.7	71.49	0.29	30	72.8	72.33	0.65
30 X 30	70.90	33.0	72.3	71.89	0.57	36	73.4	72.74	0.91

Figure 3

Figure 1a: PDD curve at FSD 100cm



Irregular Field Correction:- The mantle field extends from the tip of the mastoid process to the junction of the tenth and eleventh thoracic vertebrae and includes the axilla laterally. The treatment volume is encompassed by a large field to the upper half of the body with shielding to the oral cavity, larynx, lungs, humeral heads and cervical and thoracic spine. With such irregular fields Clarkson's method is adopted for dose calculation. Comparatively in this study direct dosimetry is performed with the shielding blocks to determine the absorbed dose.

Dosimetry:- A bare isotropic source of radiation follows inverse square law. But the radiation beam from a Teletherapy unit does not follow the inverse square law principle as the scatter contribution from the collimator contaminates the beam and the source of radiation is not isotrpic. In this study the absorbed dose is obtained by performing dosimetry at FSD 100 cm and FSD 120 cm using TRS-398 protocol. RFA water phantom of dimension (60 X 40 X 40 cm^3) with Advanced Therapy Dosimeter and 0.6 cc cylindrical water proof ion chamber (PTW TN-30013) calibrated at BARC, India on 13-06-2007 is used. The absorbed dose at 10 cm depth for FSD 100 cm and 120 cm for various field sizes along the central axis is obtained by irradiating the chamber for 100 MU, which is represented in graphical form in Fig. 2. and the values are compared with the calculated values of applying inverse square law. Similarly for the given mantle field the dosimetry is performed with the shielding blocks and the given field size to determine the Monitor Units. By which we can avoid all the correction factors that is usually applied for calculation of absorbed dose at extended FSD.

Figure 4

Figure 2: Absorbed dose at 10 cm for various field size and FSD

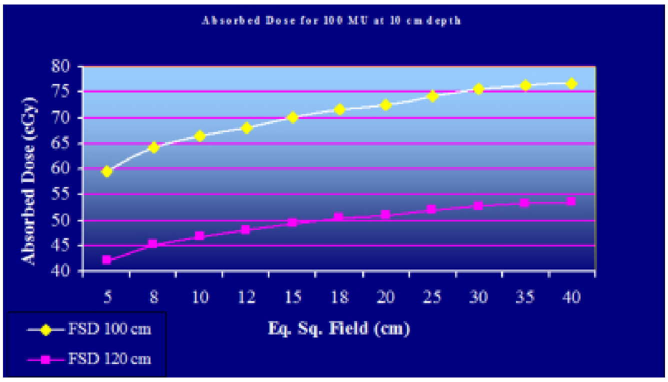


Figure 5

Table 2 : Comparison of absorbed dose at various FSD

Sl. No.	Field Size at FSD 100cm (cm x cm)	Measured Absorbed Dose at 10 cm depth for 100 MU (cGy) FSD = 100cm	FSD = 120cm	Calculated Absorbed dose at 10 cm depth for FSD 120cm (inverse square law) (cGy)	Percentage Error (%)
1	05 X 05	59.42	42.08	41.26	-1.94
2	08 X 08	64.2	45.32	44.58	-1.63
3	10 X 10	66.41	46.87	46.12	-1.60
4	12 X 12	68.13	48.03	47.31	-1.50
5	15 X 15	70.11	49.34	48.69	-1.32
6	18 X 18	71.67	50.28	49.77	-1.01
7	20 X 20	72.48	50.99	50.33	-1.29
8	25 X 25	74.22	52.01	51.54	-0.90
9	30 X 30	75.48	52.83	52.42	-0.70
10	35 X 35	76.38	53.33	53.04	-0.54
11	40 X 40	76.65	53.54	53.23	-0.58

DISCUSSION

From the study the following observation where made:-

It is found that the d_{max} migrates towards the surface with increasing FSD. This is because of the degradation of the beam quality with increase in FSD.

The d_{max} migrates to the surface with increase in Field Size. The secondary electrons produced from the collimator surface contaminates the beam and hence the d_{max} migrates to the surface with increase in Field Size.

The PDD value increases with increase in Field Size. This is a relative measurement and the behavior of the PDD with field Size is shown in Fig. 1.

The PDD value increases with increase in FSD. Thou the beam out put decreases with increase in FSD the PDD value behaves in a different way. Since PDD values are obtained by relative measurement this can not be compared with the out-put of the beam.

As expected the out put of the beam decreases with increase in FSD and dose not follow inverse square law as the scatter component from the collimator will not be taken into account while applying inverse square law.

In Table 2 the percentage error in comparison of the absorbed dose calculation by direct dosimetry and by applying inverse square law shows that all the values are negative, which clearly indicates that the scatter component will not be taken into account by applying inverse square law.

In Table 2 it can be understood that with increase in Field Size the percentage error decreases. This is because the measurement is carried out along the central axis of the beam, at bigger field size the scatter component from the collimator has to travel a longer distance to reach the central axis of the beam by the time they get degraded.

CONCLUSION

Thou the conventional method of applying correction factors to calculate absorbed at Extended FSD is within acceptable limits, it will be more appropriate to carry out dosimetry at Extended FSD with the shielding blocks and prescribed field size. This method is a step forward close to precision in dosimetry and is practically achievable.

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