Determination and Comparison of PDD and Isodose Curves for different depths of EBT Films

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1. Introduction

Basal Cell Carcinomas (BCC) grow from the layers of skin cancer present along the lowest layer of epidermis and are the most common form of skin cancer. About 80% of skin cancers develop from this type of cell. This cancer is unlikely to spread from your skin to other parts of your body, but it can move into nearby bones and other tissues under your skin. BCC can look different, however, skin growth in a dome shape that has blood vessel can be observed in all forms. Fig.1 shows the early warning signs of the skin cancer having different shapes and colors.

The probability of recurrence for this particular type of cancer depends on the size of the tumor. Small tumors are less likely to appear as compared to large size tumor. However, it has been found that, with the Mohs surgery the probability of recurrence is less than 5% whereas it can be up to 15% or higher with some other surgical treatments. Alternative to surgical treatment, a device named miniature x-ray tube can be used for the cancer treatment [1].

In this study, a new technique to plot the isodose curves and Percentage Depth Dose (PDD) that are used to test the validity of miniature x-ray tube is developed using MATLAB code. The results are in good agreement with already published data in publically accessed literature.[2]

Fig.1. Spot the early warning signs of skin caner

2. Methods and Materials

In this Section, working of the miniature x-ray tube, the detailed methodology and experimental setup used for plotting isodose curves and PDD has been discussed.

2.1 Miniature X-ray tube and treatment procedure

In miniature X-ray tube, a hollow cylindrical section produce the x-ray beam which is guided into a hollow needle like collimator before hitting the target Poly Methyl Meth Acrylate (PMMA) rectangle sheet as shown in Fig 2. The PMMA sheet has water phantom (human skin tissue) like property and therefore, can be used for the experimental purposes.[3]

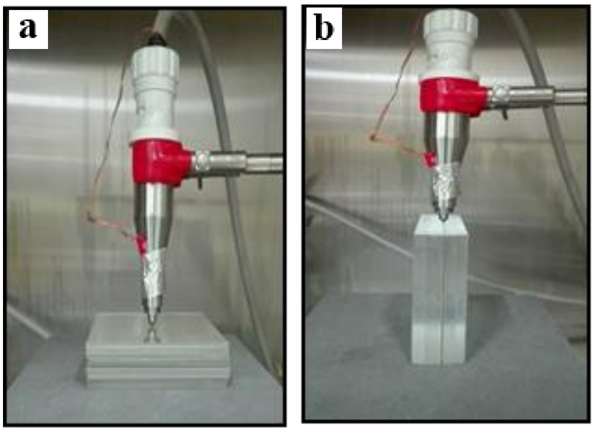

Fig.2 (a) (Horizontal Axis) (b) (Longitudinal Axis)

These X-rays have ability to penetrate in the skin up to some extent depending upon the energy of X-rays. Due to collimated X-rays, authors are able to bombard these on the different layers of EBT film in various ways. Based on this approach, skin cancer of various depths can be treated.

For this purpose, different experiments have been designed and performed to determine the dose depths, dose quantity and isodose curves at specific location on the skin.

2.2 Detailed methodology

Fig. 3 shows the detailed methodology and the systematic procedure of this study. The block diagram explains the step by step procedure. In step one the x-ray source is bombarded on the EBT and PMMA films and the obtained data is processed using MATLAB code and finally the results are analyzed.

Section 3 discuss the details of the analysis performed on the isodose curves and PDD plots.

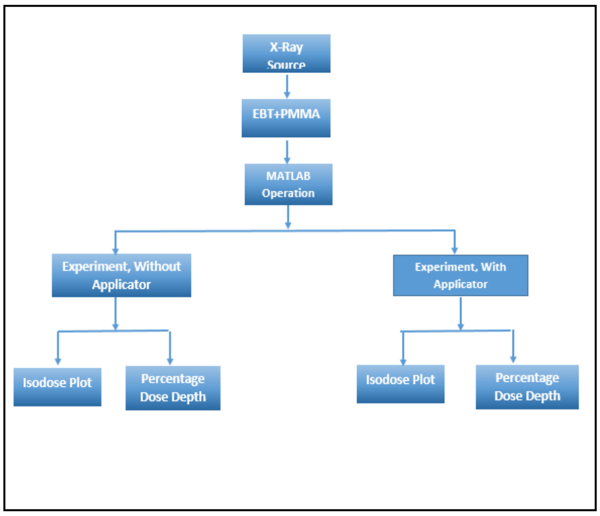

Fig.3 Flow chart of complete experiment

2.3 Experiments

Bombardment of X-rays take place on the EBT film, spreading of dose pattern have formed from center to periphery of EBT film Considering the properties of skin layers, new technique have been introduced in which many EBT films are placed like sandwiched, in between squared PMMAs of 1mm depth each as shown in Figs. 2(a) and 2(b).

Another experiment is performed, in which bombardment of X-rays on the two dimensional EBT film (vertical position) to observe the continuous pattern of isodose. Observations have shown that the results of these two experiments are quite similar as shown in Figs. 4(a) and 4(b).

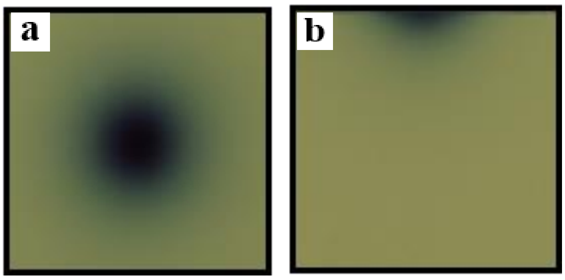

Fig.4 (a) (Horizontal Axis) (b) (Longitudinal Axis)

3. Isodose Curves

From the aforementioned experiments, isodose plots have generated using MATLAB. Very clear and continuous dose distribution from the center to periphery up to 250 mm, dose depth up to15 mm and percentage of dose in color bar can be clearly seen in these plots as shown in Fig.5 (a). In the next experiment, which is sandwiched technique, the measurement of dose distribution from center to the periphery up to 30 cm, dose depth up to 14 mm and dose quantity in percentage has been shown in color bar of Fig.5 (b).

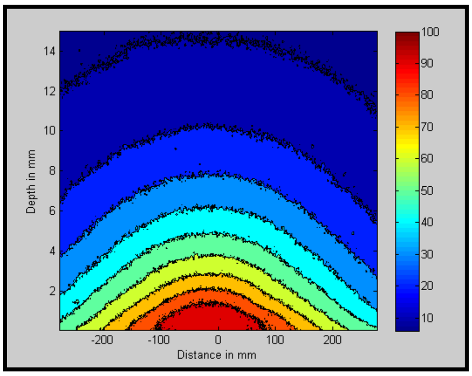

Fig.5 (a). Isodose plot of EBT film in longitudinal axis

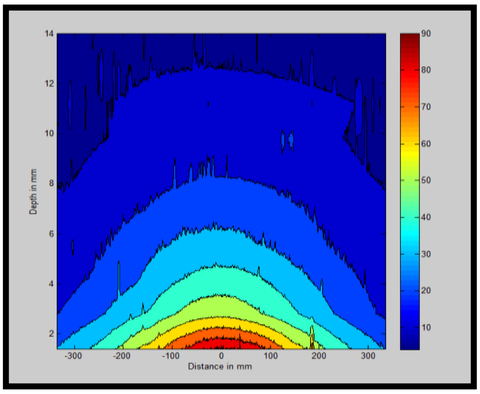

Fig.5 (b). Isodose plot of EBT film in horizontal axis

With comparison of these isodose plots, authors came to conclusion that the X-rays generated and bombarded on EBT film, with similar effects. For more analysis using MATLAB, percentage depth dose is calculated. Percentage depth dose and isodose plots are compared with other treatment devices.

3.1 Percentage Depth Dose (PDD)

Analysis of PDD data show some simple numerical relationships, which exists between the magnitude of this dose and size of the portal, the focal distance, and the half value in copper of the incident beam. The percentage depth dose is found by dividing the intensity measured at the depth by that measured at the surface.

In previous experiments, MATLAB and MCNP has generated PDD curves for certain depth of EBT film of same X-ray tube. This experiment is done without applicator.[4-5]

3.2 Depth dose rate distribution measurement

Dose rate distribution of the radiation emitted by the beryllium (Be) target in a PMMA water equivalent phantom was measured by positioning the dosimeter at different distances from the center of the target in a direction perpendicular to the optical axis of the needle. A stack of 12 rectangular PMMA plates, each 1 mm thickness with face dimensions 10x10 cm^2, has been interposed between the needle walls and the dosimeter.

The results of PDD using MATLAB and MCNP has measured for both experiments, it shows as the depth increases then dose quantity decreases with the concept of inverse square relation. Both experiments has done without applicator and without Al filter. The results are shown in Figs. 6(a) and 6(b).

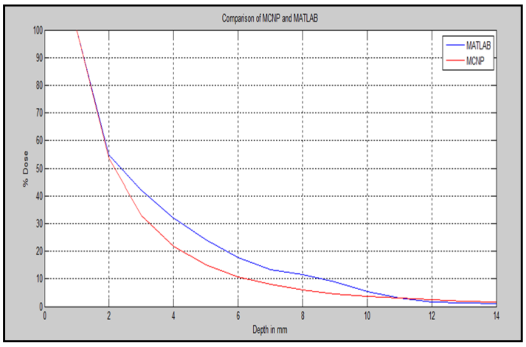

Fig.6 (a) PDD of our experiment MATLAB & MCNP (Without applicator)

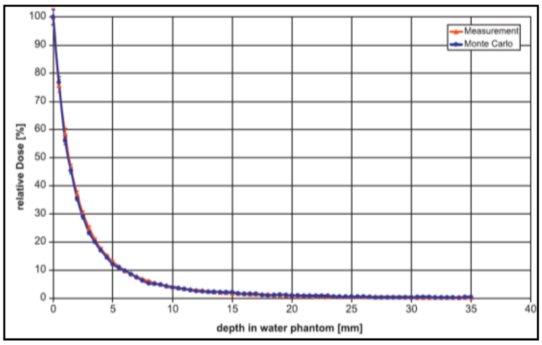

Fig.6 (b) PDD of IORT device (Without applicator)

Conclusions

Recommendations and systematic studies regarding relative dosimetry for kilovoltage x-ray beams are lacking in literature. The variation in the relative dose response were found to be very low. The measurement of percentage depth dose data (PDD) for the beam qualities studied with an uncertainty of about 3%.

References

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