Neutron contamination in conventional 3D-CRT treatment and step and shoot IMRT technique using 10 MV photons

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BACKGROUND

- When LINACs are operated above 8 MeV neutrons are produced through (e, n) and (γ, n) reactions.
- Recently the high energy medical linear accelerators operated above 10 MV are widely utilized to eliminate tumor cell.
- In addition to required photons Linac also produce undesirable particles such as neutron, which raise concern about radiation dose due to high ranges and high LETs of their interaction product

PURPOSE

The purpose of this study is to measure neutron contamination by using patient's treatment plans for both step and shoot IMRT and 3D CRT techniques for less neutron contamination that lead to minimum patient exposure from neutrons.

MATERIALS AND METHODS

- Treatment plans of 5 breast cancer patients were optimized with two different modalities i.e. three dimensional conformal radiation therapy and step and shoot intensity modulated radiation therapy using 10 MV photons and treatment planning system XiO for Elekta Synergy.

- All the measurements for each field were determined and measured by placing each patient's source to surface distance (SSD) on the surface of neutron detector.

- For measuring neutrons in primary beam, a portable, Ludlum neutron detector is used. (Fig. 1) Programmable display units in Ludlum neutron detector are represented in R/hr, Sv/h, cpm, or cps with multipliers of micro (μ) or milli (m) for R/hr and Sv/h and kilo (k) for cpm or cps.

- The neutrons are detected, not directly, but through nuclear reactions, which result in energetically charged particles, such as alpha particles. Experimental set is shown in figure 2.

Fig. 1: Ludlum Neutron Detector

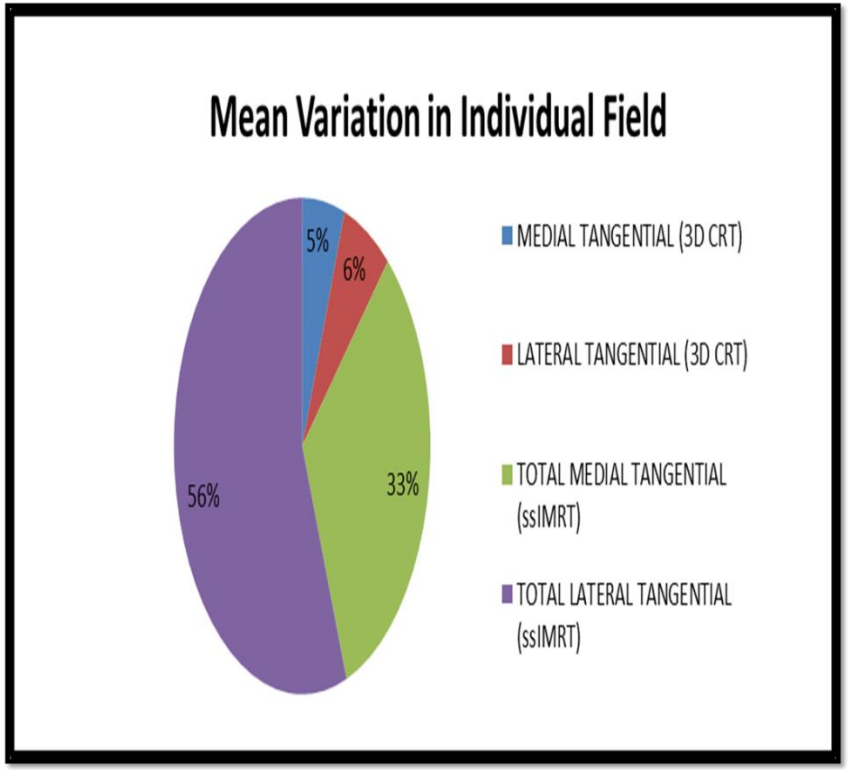
Fig. 2: Setup for Measurement of Neutron Contamination in 3D CRT AND ssIMRT

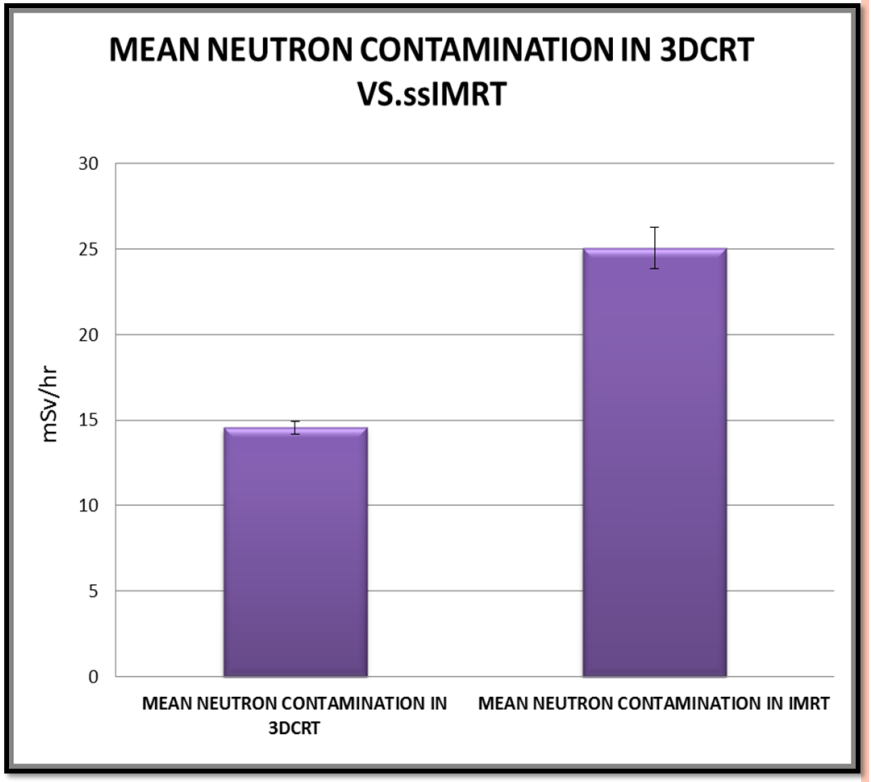
RESULTS

- The purpose for the conduction of this study was to evaluate two different treatment techniques for neutron contamination. Lateral tangential and medial tangential fields for 3D CRT were compared with total lateral tangential and total medial tangential for IMRT, respectively.

- Mean value with standard error for each field was calculated to be, 14.18±1.3, 14.94±1.41, 23.83±3.22 and 26.3±4.2 for medial tangential field of 3D CRT, lateral tangential field of 3DCRT, total medial tangential field of ssIMRT and total lateral tangential field of ssIMRT, respectively.

- The mean variation in each field was calculated to be 5% in medial tangential field of 3D CRT, 6% in lateral tangential field of 3DCRT, 33% in total medial tangential field of ssIMRT and 56% in total lateral tangential field of ssIMRT. (Fig. 3). Mean difference between two techniques for neutron contamination was calculated and was found to be 10.5. This value indicates the percent increase in neutron contamination ssIMRT. (Fig. 4)





Individual Field of 3D CRT and ssIMRT

Fig. 4: Mean Neutron Contamination in 3D Conformal Radiotherapy and Step and Shoot Intensity Modulated Radiotherapy

CONCLUSION

It was observed in our study that when 3D conformal radiation therapy and step and shoot IMRT techniques were differentiated, it was find out that the neutron contamination increases in step and shoot IMRT by a factor of about 10.5. This increase in neutron contamination in step and shoot IMRT is mainly due to the increase in number of monitor units (MUs) in the patient's treatment plan.