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ABSTRACT

Intensity modulated radiotherapy (IMRT) is the most important technical advancement in radiation therapy which has the capability of producing dose distributions that are far more conformal than that of three-dimensional conformal radiotherapy (3CDRT) and this becomes more useful when the tumor is of concave and/or complex shape, encompassing the organ at risk or normal tissue. IMRT can be delivered to patients only if treatment parameters have been verified accurately before treatment. The aims and objectives of this research work were, to study the dosimetric and quality assurance (QA) aspects of compensator based IMRT, to study MatriXX utility for QA of IMRT, to study the dosimetric impact of photon beam energy on IMRT plans and to study and analyze the results of compensator based IMRT for head and neck cancer.

Compensators for IMRT are designed in such a way that they produce optimized primary fluence profile over the patient’s surface. In this work, we have discussed the technical details with regard to inverse treatment planning, manufacturing of compensators, their QA and dosimetric results with regard to tumor coverage and normal tissue sparing. In our study, for 48 patients, compensators revealed a deviation in central axis dose of 2% ±1.8% in terms of cumulative calculated versus measured dose. Target coverage for high dose volume (70 Gy) was adequate in terms of volume receiving 93% and 95% of the prescription dose, which was 98.5% and 97.5% respectively. Parotid and other critical organs were spared adequately. Contralateral parotid (CLP) was spared. V30 Gy and V35 Gy was 55.9% and 36.8% for CLP and average dose was 31.7 Gy. Median variation in cumulative measured dose versus
cumulative calculated dose was 1.8% (SD + 1.8) and mean variation was 2.5% (95%CI 1.5, 2.6). Range was 0 to 7%.

Segmental multileaf collimator (sMLC) is another technique to deliver IMRT. In this work, the results of a dosimetric evaluation of a 2D ionization chamber array (MatriXX IBA Dosimetry, Sweden) with the objective of its implementation for QA and dosimetric verification of segmental IMRT in clinical environment for 356 modulated beams are presented. We have found that gamma and distance to agreement is passed in more than 97% of beams with a 3% and 3 mm criteria and coefficient of correlation was 0.987 (SD 0.047).

IMRT is increasingly being used nowadays in cervical cancer since several studies have reported dosimetric and clinical benefit over conventional whole pelvis external beam radiotherapy. In this work, we have investigated whether 15 MV beam IMRT offers better target coverage and normal tissue sparing in comparison to 6 MV for Ca Cx. A cohort of 16 patients was selected for this study. All patients were to receive a dose of 50 Gy in 25 fractions. IMRT plans were generated for both energies using same dose-volume constraints. Our result shows comparable coverage of planning target volume (PTV) for both energies. Volume of PTV receiving prescription dose is 97.82% (SD 0.50) and 98.8% (SD 0.43) for 6 MV and 15 MV plan. Volume of PTV receiving a dose of 107% is 4.45% (SD 7.81) and 16.1% (SD 22.18). Bladder and rectum mean doses for 6 MV and 15 MV plans were 39.83 Gy (SD 3.06) and 40.06 Gy (SD 3.17) and 35.79 Gy (SD 3.14) and 36.01 Gy (SD 3.14) respectively. Homogeneity Index (HI) for both energies was same. Conformity index at 98% isodose (CI 98) were 1.29 (SD 0.10) and 1.35 (SD 0.11) for 6 MV and 15 MV respectively.
In presented work, we have shown our results with special emphasis on the pattern of failure and its correlation with dosimetric parameters. At 2 and 3 years, the locoregional relapse-free survival rates were 68.3% and 60.8%, respectively, while the overall survival rates were 84.1% and 81.7%, respectively.

The conclusions from the research carried out in this work are as follows. Our clinical experience with compensator based IMRT clearly indicates its usefulness in terms of target coverage and organ at risk sparing. We have found MatriXX to be energy and dose rate independent. The minimum read out time is 20 ms, it allows us to measure and analyze dynamic processes like dynamic IMRT. MatriXX is a useful device for IMRT pre treatment QA as it is time saving, efficient, easy to use and it can be used for both relative and absolute dose measurements. Our study of dosimetric evaluation of 6 MV and 15 MV photon beam IMRT plans for Ca Cx indicated that 6 MV plans produce relatively less hot spots than 15 MV plans though the clinical impact of these dosimetric improvements remain unanswered. Our results revealed that, there is no clinical advantage of 15 MV over 6 MV when comparing the target coverage and normal tissue sparing. Our target selection and delineation approaches are validated in this analysis with no recurrences in this volume. A larger dataset and longer follow up is required to validate these results. The locoregional control rate possibly may be improved by addressing tumour biology. Hypoxia imaging and targeting is an interesting future prospect.