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Investigation of radiation doses to organs at risk (OAR) using intensity modulated radio therapy (IMRT) and three dimensional conformal radio therapy (3D-CRT) treatment techniques in head & neck and prostate cancer

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Purpose: Treatment planning for head & neck and prostate cancer is complex due to the number of organs at risk (OAR) located near the planning treatment volume (PTV). Distant OAR must also be taken into consideration. Intensity-modulated radiotherapy (IMRT) and three-dimensional conformal radiotherapy (3D-CRT) are both common head & neck and prostate cancer treatment techniques with very different planning approaches. Although IMRT allows a better dose conformity in PTV, there is much less evidence as to which technique less dose to OAR is delivered. Therefore, the aim of the study was to compare IMRT to 3D-CRT treatment in terms of dose distribution to OAR in head & neck and prostate cancer using the clinical radiotherapy equipments at hand in our department.

Materials & Methods: The treatment plans were optimized for an Elekta Precise Linear Accelerator using the precise treatment planning system (version 2.15) for radiation planning of the patient cases. A total of 12 patients have been used, half diagnosed with head & neck and half with prostate cancer. The patients had all prior to this work received treatment according to the ARTSCAN protocol using for planning and treatment technique. In all cases, patients were treated with IMRT, although a 3D-CRT treatment plan was also developed for the comparative analysis. To compare doses to specific OAR, we developed a new comparative index based on sub-volumes. The influence of different planning parameters (such as number of fields, number of intensity levels and segments per beam) on the dose distribution was investigated. The dose-volume distribution aimed for are according to the ARTSCAN protocol, i.e. 95–105% of the prescribed dose to the planning target volume (PTV), including bilateral nodes. The treatment plans were evaluated in terms of physical quantities based on dose–volume histograms and isodose distributions.

Results: It is shown that the optimal IMRT settings for the given situation, is to use seven coplanar beams, separated by equal angles, different intensity levels and segments per beam. The dose-volume constraints for the PTV need to be stricter than the 95–105% aim and the organ at risk (OAR) constraints must usually be set to a lower level than the actual tolerance doses. The IMRT plans show slightly worse PTV coverage and a larger standard deviation than the 3D-CRT plans, but the doses to the organs at risk are on the other hand lower. It is also shown that the quality of an IMRT plan is strongly dependent on the equipment used. The plan optimized with standard equipment showed better dose conformity and lower standard deviation as well as lower normal tissue doses.

Conclusions: This work shows the possibilities of normal tissue sparing using IMRT. The mean doses of OAR can easily kept below the threshold dose in the IMRT plans as compared to 3D-CRT.

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