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Reduction of the Risk of Secondary Cancer Induction Using VMAT for Head and Neck Cancer

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Abstract : The purpose of this analysis is to estimate secondary cancer risks after VMAT compared to other modalities of head and neck radiotherapy (IMRT, 3DCRT). Computer tomography (CT) scans of Radiological Physics Center (RPC) head and neck phantom were acquired with CT scanner and exported via DICOM to the treatment planning system (TPS). Treatment planning was done using four arc (182-178 and 180-184, clockwise and anticlockwise) for volumetric modulated arc therapy (VMAT) , Nine fields (200, 240, 280, 320,0,40,80,120 and 160), which has been commonly used at MD Anderson Cancer Center Houston for intensity modulated radiation therapy (IMRT) and four fields for three dimensional radiation therapy (3DCRT) were used. True beam linear accelerator of 6MV photon energy was used for dose delivery, and dose calculation was done with CC convolution algorithm with prescription dose of 6.6 Gy. Primary Target Volume (PTV) coverage, mean and maximal doses, DVHs and volumes receiving more than 2 Gy and 3.8 Gy of OARs were calculated and compared. Absolute point dose and planar dose were measured with thermoluminescent dosimeters (TLDs) and GafChromic EBT2 film, respectively. Quality Assurance of VMAT and IMRT were performed by using ArcCHECK method with gamma index criteria of 3%/3mm dose difference to distance to agreement (DD/DTA). PTV coverage was found 90.80 %, 95.80 % and 95.82 % for 3DCRT, IMRT and VMAT respectively. VMAT delivered the lowest maximal doses to esophagus (2.3 Gy), brain (4.0 Gy) and thyroid (2.3 Gy) compared to all other studied techniques. In comparison, maximal doses for 3DCRT were found higher than VMAT for all studied OARs. Whereas, IMRT delivered maximal higher doses 26%, 5% and 26% for esophagus, normal brain and thyroid, respectively, compared to VMAT. It was noted that esophagus volume receiving more than 2 Gy was 3.6 % for VMAT, 23.6 % for IMRT and up to 100 % for 3DCRT. Good agreement was observed between measured doses and those calculated with TPS. The averages relative standard errors (RSE) of three deliveries within eight TLD capsule locations were, 0.9%, 0.8% and 0.6% for 3DCRT, IMRT and VMAT, respectively. The gamma analysis for all plans met the ±5%/3 mm criteria (over 90% passed) and results of QA were greater than 98%. The calculations for maximal doses and volumes of OARs suggest that the estimated risk of secondary cancer induction after VMAT is considerably lower than IMRT and 3DCRT.

Keywords : RPC, 3DCRT, IMRT, VMAT, EBT2 film, TLD
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