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Volumetric Modulated Arc Therapy Vs. IMRT: a Treatment Planning Comparison for Larynx, Oro- and Hypopharynx Carcinomas

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Background: Volumetric intensity-modulated arc therapy (VMAT) is an emerging radiation therapy technique allowing for rapid delivery of highly conformal treatments. In this study, the treatment plans for VMAT and static-field intensity-modulated radiation therapy (IMRT) for head and neck cancer patients were compared.
Material and Methods: The last 10 patients who underwent static-field IMRT for larynx, oro- and hypopharynx carcinomas treatment were replanned using VMAT with two dynamic arcs. Both plans were prescribed to deliver 70 Gy to the gross tumour, 60−64 Gy to intermediate-risk areas and 56 Gy to low-risk areas. Dose to the planning target volume (PTV) and organs at risk (OAR) were evaluated according to ICRU recommendations and compared. For the PTV we evaluated the V95%, near-maximum (D2%), near-minimum (D98%) and median (D50%) doses received by the target volumes. Homogeneity indexes (HI) and conformity indexes (CI) were calculated. D2%, maximum dose (Dmax), mean dose (Dmean) or volume receiving a relevant dose were used for OAR. Monitor units (MU) were also documented.
Results: Both IMRT and VMAT can provide good PTV coverage (D98% >95%, V95=100%). The dose to the 70 Gy PTV tends to be more homogeneous for the IMRT plans (HI = 0.08 for IMRT vs. 0.1 for VMAT, $p = 0.068$). The HI indices are similar for the 60−64 Gy PTV (0.12 vs. 0.13) and the 56 Gy PTV (0.15 vs. 0.16). CI was similar for both techniques: 1.62 (1.28–3.28) for IMRT vs. 1.81 (1.24–3.07) for VMAT. Spinal cord Dmax <45 Gy in most cases, with D2% lower for IMRT (41 vs. 42.25 Gy, $p = 0.025$). Brainstem Dmax <54 Gy for all patients with both techniques (median Dmax=49.9 vs. 49.25 Gy, $p > 0.05$). Dmean was higher for IMRT vs. VMAT for both right (30.15 vs. 29.37 Gy) and left (42.45 vs. 40.8 Gy) parotids, as was D50% for right (26.44 vs. 26.25 Gy) and left (38.95 vs. 37.8 Gy) parotid glands. VMAT allowed for a reduction in Dmax (73.2 vs. 75.75 Gy) and D2% (69.86 vs. 72.2 Gy) for the mandible. Both techniques give comparable oral cavity Dmax and D2%. Esophagus Dmean <45 Gy in most cases. MU for VMAT were significantly lower (494 vs. 1472, $p < 0.001$).
Conclusions: This planning study shows that both IMRT and VMAT provide comparable PTV coverage. While IMRT can achieve better target dose homogeneity, VMAT is better at sparing doses to OAR in some cases. Overall, both techniques seemed to be equivalent. MU were considerably lower for VMAT, resulting in a shorter delivery time that can benefit patients and department logistics.

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A Dosimetric Comparison Between Single Arc and Double Arc Technique Using Volumetric Modulated Arc Therapy for Brain Metastases

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Purpose: Volumetric modulated arc therapy (VMAT) is a technique allowing for highly conformal intensity-modulated dose distributions by delivering with gantry rotation. We compared the difference VMAT plans between using single arc (SA) technique and double arc (DA) technique.
Methods and Materials: We selected the 7 patients with brain metastases who had been treated with whole brain radiotherapy followed by VMAT boost. For each patient, two VMAT plans consisting of SA and DA technique were generated to brain metastases. These all plans were optimized according to VMAT technique with same optimized condition. Dose prescription was 3 Gy in 10 fractions without normalization. For comparison, we used the quality of coverage (QOC), homogeneity index (HI) and conformity index (CI), which was defined by the Radiation Therapy Oncology Group (RTOG). The dose volume histograms (DVH) also were evaluated.
Results: Summated planning target volumes (PTV) were 7.2 to 122.3 cc (median 44.7cc). The DA technique showed significantly better averaged HI (1.14) compared with the SA (1.19) and the VMAT plans using DA technique showed much steeper PTV dose gradients than SA technique on DVH. The sparing of OAR (brain, lens, and brain stem) was not significantly different between the double arc VMAT and single arc VMAT.
Conclusions: Compared with VMAT plan using SA technique, DA technique provided significantly more homogeneous PTV coverage and similar sparing of OAR.

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A Dose-volume Analysis of Magnetic Resonance Imaging-aided High-dose Rate Image-based Interstitial Brachytherapy for Previously Untreated Uterine Cervical Cancer

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Background: To investigate the feasibility of our novel image-based high-dose rate interstitial brachytherapy (HDR-ISBT) for uterine cervical cancer, we evaluated the dose-volume histogram (DVH) according to the recommendations of the Gynecological GEC-ESTRO Working Group for image-based intracavitary brachytherapy (ICBT).
Materials and Methods: Between June 2005 and April 2009, 31 previously untreated cervical cancer patients were treated (median age, 56 years; range, 34−79 years). The eligibility criteria for undergoing ISBT were determined based on ABS recommendations (bulky lesion, narrow vagina, inability to enter the cervical os, extension to the lateral parametria or pelvic side wall, and lower vaginal extension). The survivors were followed up for a minimum of 2 year (median; 42 months, range; 24−69 months). Histological findings showed 28 squamous cell carcinomas, one adenosquamous carcinoma, and 2 adenocarcinomas. Using the UICC classification of 2002, 2 T2b, 23 T3, and 6 T4 were identified. There were 15 N0 and 16 N1 patients, and 5 patients were classified as M1 (para-aortic lymph node metastasis alone).
We implanted magnetic resonance imaging (MRI)-available plastic applicators by our unique ambulatory technique. Total treatment doses were 30−36 Gy (6 Gy per fraction) combined with external radiotherapy (ERT). Treatment plans were created based on planning computed tomography with MRI as a reference. DVHs of the high-risk clinical target volume (HR CTV), intermediate-risk CTV (IR CTV), and the bladder and rectum were calculated. Dose values were biologically normalized to equivalent doses in 2 Gy fractions (EQD_2).
Applicator displacement was evaluated by daily CT images and we compared the distance between applicator tips and center of the gravity of three marker seeds implanted in the edge of the CTV.
Results: The median D90 (HR CTV) and D90 (IR CTV) per fraction were 6.8 Gy (range, 5.5−7.5) and 5.5 Gy (4.2−6.4), respectively. The median V100 (HR CTV) and V100 (IR CTV) were 99% (83–100) and 82% (64–96.2), respectively. When the dose of ERT was added, the median D90 and D100 of HR CTV were 81.6 Gy (65.5–96.6) and 64.7 Gy (49–83.2). D_{2cc} of the bladder was 70 Gy (52.8–119) and of the rectum was 67.7 Gy (48.9–86.8). The 3-year local control rates were 100%, 92% and 67% for T2b, T3 and T4 lesions. The 3-year disease free survivals were 100%, 77% and 67% for T2b, T3 and T4 lesions. The 3-year local control rates were 93% and 81% for N0 and N1 lesions. The 3-year disease free survivals were 70% and 81% for N0 and N1 lesions. Severe late complications (Grade 3−4 in CTCAE Ver.3) were observed for 2 patients.
Conclusions: Although the tumours were advanced and difficult to treat effectively by ICBT, MRI-aided image-based ISBT showed favorable results.

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Is RapidArc Superior to 3D Conformal Radiotherapy for Radical Radiation of Primary Esophageal Carcinoma − A Dosimetric Study

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Background: Oesophageal carcinomas are traditionally treated with 3D conformal radiotherapy (3DCRT). The application of RapidArc (RA) for this site has not been previously investigated. RA has the potential to offer more conformal treatment without compromising normal tissue toxicity given that stringent dose constraints are applied. However, there is also concern that RA may produce higher V5 and mean lung doses which correlate with an increased risk of radiation pneumonitis. This current pilot study examines the feasibility of RapidArc for oesophageal radiation and lung sparing compared to 3DCRT.
Materials and Methods: 12 patients, who were treated radically between 2006–2008 to a dose of 50 Gy/25 fractions, were randomly selected from our electronic patient records. These cases equally represented upper, mid and lower oesophageal tumours. Archived patient CT simulation scans were anonymized and planned using RA and 3DCRT with the following dose constraints: PTV covered by 47.5 Gy to at least 98% volume with acceptable hotspot <110%, spinal cord Dmax <45 Gy, V20 lung <30%, mean lung dose (MLD) <20 Gy. Results were analyzed with two-tailed Wilcoxon matched pair analysis.