Optimized IGRT correction vector determined from a displacement vector field: Decision-making aid for re-planning

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Purpose/Objective: To present a new method that determines an optimized IGRT couch correction vector from a displacement vector field (DVF). The DVFs are computed by a deformable image registration (DIR) method. These DVFs describe setup variations and deformations of the patient anatomy in control-CTs in respect to planning-CTs. The proposed method can improve the quality of volume-of-interest (VOI) alignment in IGRT, and can serve as a decision-making aid for re-planning.

Materials and Methods: The method is demonstrated using the CT data sets of 11 head and neck cancer patients with daily kilo-voltage control-CTs. A DVF is computed for each control-CT using an automatic DIR algorithm based on a template matching technique. The DVF is used for voxel tracking and re-contouring of the VOIs in the control-CTs. Then a rigid body transformation, which can be used as couch correction vector, is optimized. Aim of the optimization process is to find a vector and rotations that map the deformed VOIs into a specified target. This target is defined by a margin extension of the VOIs at the time of the planning process. Within this extension, VOI position and orientation is tolerated. The optimization process considers pre-defined geometrical constraints of all VOIs considered relevant for patient alignment. The objective function in the optimization process is the sum of all volume fractions outside the defined territories. The optimization method used to find the minimum of the objective function is a widely used simplex algorithm. The method can also serve as a decision-making aid for re-planning: In this study, we chose the 'action level' for re-planning to be 2 volume-percent of each VOI. If this criterion is exceeded by any VOI, re-planning is assumed to be necessary.

Results: Using the proposed method results in smaller fractions of the VOIs lying outside the defined territory after the IGRT correction. In comparison to re-planning with an rigid registration method, the method is able to find more frequently a correction vector that fulfills the optimization goal. Also comparison to the standard IGRT correction with a version of the optimized IGRT strategy that does not consider rotations in the optimization process shows that in more fractions an acceptable alignment of the VOIs is achieved.

Conclusions: The knowledge of the deformation of the anatomy allows the determination of an optimized rigid correction vector, using our method. The method ensures controlled mapping of the VOIs despite small deformations. The manual choice of a region for registration when using IGRT will be superseded. The proposed method can also serve as a decision-making aid for re-planning or before-of-the-day concepts. If no optimized vector can be determined, re-planning should be considered. Additionally, the method helps to standardize the re-planning process and make re-planning decisions more reproducible.

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The use of adaptive planning using VMAT in head and neck squamous cell carcinoma
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Purpose/Objective: Recent evidence supports the use of adaptive planning in IMRT for HN SCC. The use of adaptive planning with VMAT delivery is unknown. We performed a retrospective planning study to identify whether adaptive planning should be applied with delivery using VMAT.

Materials and Methods: A retrospective analysis was performed on 27 consecutive patients. A repeat planning CT at fraction 16 was delineated. For delineation on the repeat scan, the original GTVs and CTVs were copied and pasted from the original scan onto the repeat scan and volumes were adjusted for changes in anatomy position, but were not reduced in size. A non-adaptive plan was created by recalculating only and an adaptive plan was created by re-optimization and re-normalization.

Results: 87% of patients received neo-adjuvant chemotherapy. The mean absolute improvement reduction in conformity number and the D99 of the dose in PTV HR was 0.06 (S.D. = 0.06) and 5.2% (S.D. = 6.67) respectively. The mean absolute improvement in conformity number of PTV LR is 0.03 (S.D. = 0.03). In terms of organs at risk, the mean difference in minimum dose to spare brainstem and median contralateral parotid were 0.3Gy (S.D. = 1.5), 0.2Gy (S.D. = 0.9) and -0.5Gy (S.D. = 2) where positive is improvement. These were a heterogeneous group of patients with median weight loss of 4.5kg (range -0.2kg to 11.3kg), median separation change at C1 and thyroid notch 0.5 cm (range 0 to 2.7cm) and 0.4cm (range -0.1 to 2.2cm).

Conclusions: Although we present a clinically feasible method of adaptive planning, in contrary to similar series there was very limited benefit to adaptive planning. This may be due to the use of VMAT, the high use of neo-adjuvant chemotherapy or patient selection. The small proportion of patients likely to benefit are likely to be in the group with changes in separation or weight, however robust data to confirm this awaited.

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The effect of image window level adjustments on auto-contouring for NSCLC patients
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Purpose/Objective: To evaluate the total lung volume and Normal Tissue Complication Possibility (NTCP), V20, V10 and V5 values for non-small-cell cancer (NSCLC) patients by using two different image window level adjustments on auto-contouring options while keeping the same tumor coverage and dose distribution.

Materials and Methods: Treatment plans were performed for 15 patients with non-small-cell cancer using IMRT at our clinic. All patients underwent CT scan; 5 mm slice thickness (Siemens Emotion Duo) in supine position with the standard wing board. A dosimetric planning studies were performed except total lung. The treatment plans were generated with Prowess Panther 5.01 for delivery with 6 MV on a Siemens Artiste linear accelerator with a 80 pair MLC. All the plans were subsequently generated using consistent planning parameters such as optimization parameters and total dose. After finishing IMRT optimization for all patients by using contours obtained from Mediastinal window-level (W:635, L:2) , the total lung’s contour was regenerated by using Lung window-level (W:1200, L:-400). For creating the total two different total lung volume, the auto-contouring option were used on treatment planning system (TPS). The total lung DVH parameters were compared with NTCP, V20, V10, V5 values and volume changes .

Results: According to the data obtained in this study when doing auto-contouring, by using appropriate of image window level is significantly important. This settings affects the NTCP, V20, V10, V5 values and volume changes for the total lung. The differences of NTCP, V20, V10, V5 values and volume changes were respectively 10.41%, 3.61% , 13.2% , 19.3% and 15.96%.

Conclusions: The auto-contouring options are commonly used at work faster clinical intensive operation. This study showed that both image window level differed significantly, care should be taken when auto contouring options as the use of selection of image window level value influence the risk of complication possibility reduced.