Comparison between two distributions of dose was done by means of DVH's of PTV, OAR and External phantom outline.

Results: The volume of the smaller phantom was 6034 cm^3 vs 6257 cm^3 of the modified volume of the bigger into the smaller (difference = 3.5%). Figure 1 shows the dosimetric comparison in terms of dvh's between DD obtained by Velocity software and PD with Masterplan TPS. D_{98} for PTV was 94% and 97.5% for DD and PD; D_{50} was the same (100%) and D_2 was 101% for DD as well as PD. Little bit difference was evident in the shape of DVH for OAR (Figure) even though no difference in terms of mean dose was found (1.22 Gy both for DD and PD). Also for external phantom volume (integral dose) the mean dose was similar (0.65 Gy for PD and 0.67 Gy for DD resulting in 3% of difference).

Conclusions: By comparing the doses accumulated in the small phantom under the condition of deformation and the doses calculated with the treatment planning, this study has demonstrated the potential of validating an algorithm that include deformations into dose computation. Since only a very simple situation was explored, future investigations will focus more on the use of anthropomorphic phantom to simulate a real situation of deformable dose accumulation.

ELECTRONIC POSTER: PHYSICS TRACK: IMAGING: FOCUS ON QA AND TECHNICAL ASPECTS

EP-1287
Software module for the characterization of geometric distortion in MRI-SIM using a large field of view phantom

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Purpose/Objective: To develop and validate an automated quality assurance software tool for the assessment and characterization of geometric distortion of MRI scanners commissioned for RT planning.

Materials and Methods: A phantom and software platform that can be used to assess geometric accuracy for clinical MR applications that require large fields of view was developed. The phantom consists of 357 rods (6 mm diameter) of polymethyl-methacrylat separated by 20 mm intervals, providing a three dimensional array of control points at known spatial locations over a large field of view (total diameter of 420mm). An in-house software module was developed to allow automatic geometric distortion assessment by: 1) segmentation of the rods in each image dataset, 2) calculation of rod positions, 3) correction of gross rotation errors due to phantom positioning during scanning and (4) comparison of corrected positions with a theoretical reference grid that simulates the known phantom geometry (ground truth). The software module was validated against a virtual CT dataset of the phantom that reproduced the exact geometry of the physical phantom, but with known translational and rotational displacements. The software module was then assessed using axial CT and MRI sequence datasets (2D T1/T2 FSE, 3D CUBE, T1 SPGR) acquired with application of a commercial 3D distortion correction algorithm (GradwarpTM).

Results: For both virtual CT and CT validation experiments, the software robustly calculated rod positions within each axial dataset with sub-voxel accuracy. For the virtual phantom measurements, mean errors in the measured coordinates of the rod positions were in the order of 0.15mm, over the entire FOV. For CT, mean errors in the measured coordinates of the rod positions were in the order of 0.23mm. For all MRI sequences, over a scan length of 15cm, mean geometric distortions (dxy) within a 10cm, 15cm, 20cm radius were found to be ≤0.5mm (range 0-1.9mm), < 0.6 mm (range 0-2.1mm) and < 0.7mm (range 0-2.8mm) respectively (with application of GradwarpTM). (Full data to be presented).

Conclusions: A robust software module for the assessment and characterization of geometric distortion in MRI has been developed and validated. Our preliminary data suggests that this method may be a valuable tool for routine quality assurance for MRI applications that require stringent spatial accuracy assessment such as radiotherapy.

EP-1288
Deformable image registration for radiation therapy planning using Velocity AI software

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Purpose/Objective: The treatment workflow for IMRT head and neck patients includes a control CT at the third week of treatment. Velocity AI is a imaging software to display, register, and segment medical image volumes from multi-modality sources. It was introduced in our clinical practice in September 2011. The purpose of the present study was to evaluate the potentialities of deformable registration applied not just to anatomic structures but also to the 3D dose matrix in both image sets.

Materials and Methods: The retrospective study included images, structures and dose data from five patients with H&N tumors treated with IMRT. The treatment planning was performed in Oncentra TPS (Nucletron/Elekta). Patient structures (PTVs and OARs) were delineated in Velocity AI 2.7. Three different image registration approaches were performed between the planning initial CT and the control CT image sets: 1) no region of interest (ROI) was defined for applying image registration; 2) a ROI was defined including the largest length of PTV in sagittal and coronal views (low and high risk lymphnodes) and 3) with a ROI involving each of the main OAR, like parotids, spinal cord, brainstem, mandible or tiroide. In all three options a rigid followed by a deformable registration was applied. The influence of the definition of a ROI on the deformed volume of the different OARs was studied. The OAR deformed structures were clinically evaluated by an experienced H&N radiation oncology who validated the second registration approach. Based on the validated deformed structure set a re-calculation of dose distribution was performed in Oncentra for the control CT and compared with the deformed dose matrix obtained with Velocity AI.

Results: For a rigid structure like the mandible yet prone to positional errors, the volume difference between the three registrations was 2% (SD 3%) but the deformed volume differed in average 7% from the initially delineated structure. For the spinal cord no differences greater than 1% (SD 2%) were observed in volume. A systematic average shrinkage of 22% (SD 10%) for the parotid glands was observed between the initial and the control CTs, in line with similar results reported in literature. Concerning dose deformation in Velocity, underestimations of up to 7.8 Gy were obtained for the maximum dose in spinal cord when compared with re-calculation in Oncentra.

Conclusions: The deformable image registration algorithm and available registration strategies in Velocity AI were tested for H&N clinical cases. The steps of the registration procedure for obtaining clinically valid deformed OARs were established. Concerning the available tool for 3D dose matrix deformation and using the results of this study we recommend additional caution, namely when tolerance dose for critical organs at risk is involved. Significant differences were obtained between the deformed dose in Velocity and the dose true calculation in Oncentra.

EP-1289
4D CT imaging artefacts in ungated and gated irradiation of the thorax region

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Purpose/Objective: The goal of traditional radiation therapy is to maximize absorbed dose in a target volume while minimizing the dose to normal, healthy tissue. This is especially challenging in the case of moving tumors due to breathing. 4DCT shows the extent of motion. In addition, it may allow the beam to be on during specific time intervals in the breathing cycle only (gating). However, 4D CT is prone to artifacts, possibly adversely affecting accuracy and hence treatment outcome of gated treatments.

Materials and Methods: Measurements were done using a 16 slice General Electric Lightspeed CT with rotation time of 1 sec. The standard thorax imaging procedure, 2 mm slices and 120 kV, was used. Half and full rotation reconstructions were used when appropriate, reconstructing in 10 phases. Tests were performed using the 'Quasar phantom', using a polystyreen sphere in a wooden cylinder. Respiratory cycles varied between 0,1, 2, 3, 4, 5, and 6 seconds per breath, amplitudes between 0.5 cm and 2 cm, and 'breathing patterns' between sine and non-sine. Polystyreen sphere volumes, shapes, and locations were measured in each phase of the 4D images, and in the Maximum Intensity Projection (MIP) of the dataset. Results were compared to that of scans made in a more conventional way: the 'slow scan' and the 'helical scan'. Finally, the effects were assessed of alternative 4D scanning protocols and an improved algorithm for peak detection of the RPM system.