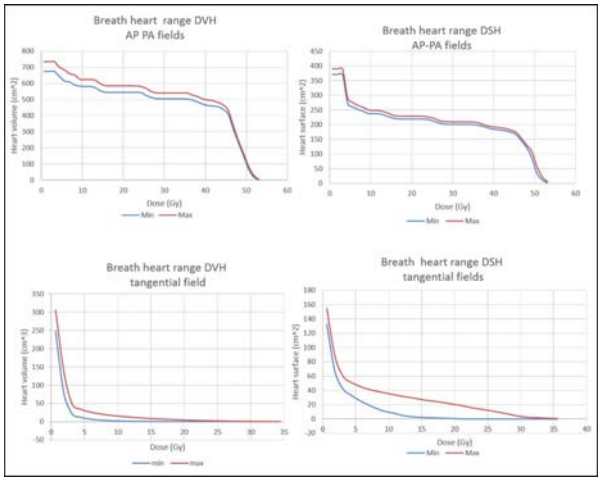
a) Contour variability				
Indices	Intra-observer		inter-frame	
Surface CV (%)	3.0		5.0	
Volume CV (%)	2.6		2.7	
	mean		mean (SD)	
Dice	0.98 (0.01)		0.97 (0.01)	
Hausdorff	2.50 (0.99)		1.80 (0.98)	
b) Dose variations				
Indeces	Cardiac-gated 4DCT		Respiratory-gated 4DCT	
	APPA	TANG	APPA	TANG
SDmean CV (%)	1.8	2.6	0.95	14.1
VDmean CV (%)	1.0	1.9	1.0	8.9
Dmax CV (%)	1.2	1.0	1.0	14.3
	median (range)		median (range)	
DSH 20-40 Gy CV (%)	4.4 (4.2-4.8)	5.0 (4.8-5.3)	1.2 (1.0-1.8)	40.0 (40.0-54.0)
DVH 20-40 Gy CV (%)	2.2 (2.1-5.4)	4.3 (4.2-4.8)	2.0 (1.8-2.3)	39.0 (36.5-46.0)

Abbreviations: CV: coefficient of variation, SDmean: surface mean dose; VDmean: volume mean dose, Dmax: maximum dose, DSH: dose surface histogram, DVH: dose volume histogram

Figure 1



Conclusions: Our study showed that intra-fraction heart motion has a negligible impact on estimated heart doses with a level of dosimetric uncertainty comparable to that inherent to structure delineation, when AP-PA beam setup is considered. On the contrary, dose volume/surface parameters estimation from tangential field plans could be affected by the large uncertainty due to random respiratory heart motion. This should be taken into account for monitoring treatment outcome and if reliable and robust NTCP modelling have to be performed from retrospective heart dosimetric analysis in breast cancer patients.

PO-0970

Assessment of regional positional repeatability in head and neck using a dedicated MR simulator

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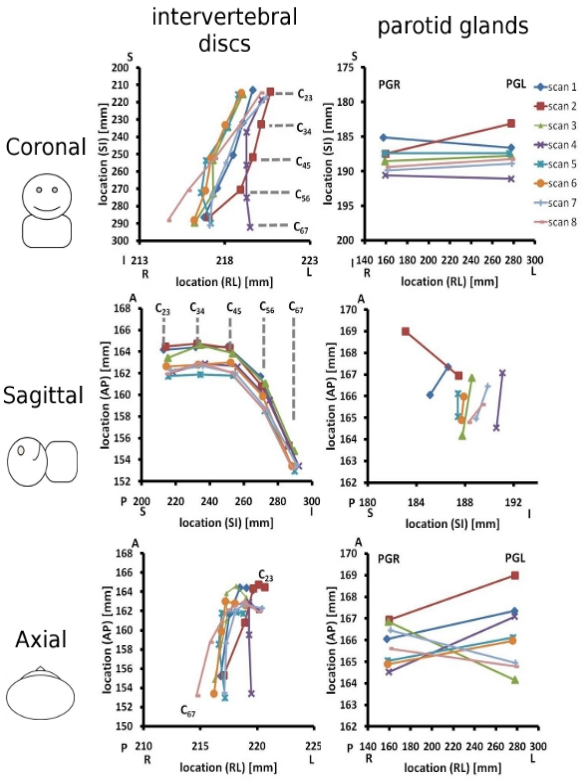
Purpose/Objective: Positional accuracy and precision is vital in radiotherapy. The use of MRI for radiotherapy is increasingly gaining great interests but the achievable positional repeatability on dedicated MR-simulator has not yet been determined. This study aims to assess the positional repeatability in head and neck on a 1.5T MR-simulator using cervical spine discs and parotid gland (PG) as landmarks.

Materials and Methods: Eight sets of T2-weighted MR images of a healthy volunteer were acquired (TR/TE=2000/130ms; FOV=44cm; matrix=512x512; 271x1mm coronal slice; 2 NEX; 3D geometric correction on) over 2 months using a 1.5T MR-sim (GE Optima MR450w). The volunteer was immobilized using a standard 5-point open-face immobilization system. Permanent marks were labeled on thermoplastic mask as positioning reference. VOIs of intervertebral discs from C2 to C7 (C_{23}, C_{34}, C_{45}, C_{56}, C_{67}), and bi-lateral parotid glands (PGL, PGR) were drawn by two physicists specialize in MRI. 3D volume centroid was calculated for each VOI. Inter-session positional shift was calculated as the VOI centroid displacement with respect to the first session. The inter-session rotations of discs and PG were calculated using C_{23} and PGL as references. 3D vectors were determined by centroids of the selected and the reference VOI. Rotation angles (roll, pitch and yaw) were then calculated using the angle between the projected vectors (on axial, sagittal and coronal plans, respectively) with respect to the first session.

Results: Averaged shifts, rotations and their ranges were shown in Table 1. Averaged LR and AP shifts for discs were within 1mm and 2.5mm respectively, comparable with previous CT studies. Noticeable discrepancies were found in LR and AP shifts between PGL (-0.24 and -1.34mm) and PGR (1.97 and -0.30mm). This might indicate the greater freedom of mobility and/or deformation in soft tissues than in hard tissues. Whether these mobility and deformation were inherent or passively induced by immobilization should be further delineated. Relatively large SI shifts were observed for all VOIs, probably due to the dockable couch design for this MR-sim. The largest rotation was observed in roll for discs. For PG, larger rotations were found in pitch and yaw instead. These might be explained by the use of open-face in absence of mouth-bite. Regional positional variations between scans were shown in Fig. 1. Note that the large pitch value for PG was attributed to its short projected distance on sagittal plane.

ROIs	LR Shift mean [range] (mm)	SI Shift mean [range] (mm)	AP Shift mean [range] (mm)	Roll mean [range] (deg)	Pitch mean [range] (deg)	Yaw mean [range] (deg)
C_{23}	0.1 [-0.85 , 1.04]	2.75 [1.04 , 5.42]	-1.52 [-2.44 , 0.29]			
C_{34}	-0.29 [-1.04 , 1.07]	2.83 [1.06 , 5.56]	-1.19 [-2.54 , 0.33]	-5.18 [-30.28 , 13.36]	0.98 [-0.30 , 2.84]	1.19 [-0.09 , 3.22]
C_{45}	-0.51 [-1.60 , 1.17]	2.96 [1.22 , 5.67]	-1.63 [-2.66 , -0.11]	6.74 [-15.75 , 20.62]	-0.18 [-0.82 , 0.32]	0.91 [-0.43 , 2.35]
C_{56}	-0.11 [-1.72 , 1.72]	2.65 [0.91 , 5.47]	-2.1 [-3.16 , -0.64]	4.89 [-13.07 , 21.29]	-0.60 [-1.21 , 0.13]	0.22 [-1.21 , 2.23]
C_{67}	0.06 [-2.13 , 2.71]	2.84 [-0.06 , 5.70]	-1.42 [-2.25 , 0.12]	-0.01 [-14.29 , 13.28]	0.09 [-0.24 , 0.30]	0.03 [-1.70 , 2.01]
PGL	-0.24 [-1.74 , 0.75]	1.18 [-3.50 , 4.49]	-1.34 [-3.19 , 1.64]			
PGR	1.97 [0.86 , 3.61]	3.60 [2.30 , 5.47]	-0.30 [-1.52 , 0.88]	-0.50 [-1.91 , 0.62]	14.64 [-66.16 , 48.61]	-1.17 [-2.84 , -0.47]



Conclusions: Our results in discs suggest that comparable positional repeatability could be achieved on MR-sim to that in real RT-treatment as previously revealed by CT. More importantly, we illustrated on MR-sim, for the first time, that organ at risk like PG could present pronounced inter-scan positional variability, suggesting the potential merit of MR-sim to visualize soft tissue for inter-fraction positional verification in head and neck radiotherapy to reduce toxicity.

PO-0971

Segmentation of organs at risk using superpixels on MRI or CT images in prostate radiotherapy

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Purpose/Objective: Segmentation of organs at risk (OAR) in male pelvis is critical for planning prostate cancer radiotherapy. Our aim was to segment OAR of male pelvis (i.e. femoral heads, bladder and rectum) on MRI or CT images, using a 3D semi-automatic method based on a superpixel algorithm.

Materials and Methods: The initial step consists in uniformly positioning *K* seeds on the image to be segmented. These seeds are expanded over the image by aggregating similar neighboring pixels forming so-called superpixels through an Eikonal-based region growing clustering algorithm. Then, an adjacency graph is calculated from these superpixels. The user selects several superpixels belonging to each OAR to be segmented, so that the corresponding nodes in the adjacency graph are labelled. The final segmentation is obtained by carrying out a graph diffusion. The influence on segmentation results of the number (*K*) of superpixels has been assessed with Dice Indices (DI) on 7 MRI and 8 CT patients' data with respective sizes of 320×320×20 and 512×512×148 pixels. The gold standard was the segmentation performed by an experienced radiation oncologist. The intra-user reproducibility has been evaluated and our results have been compared with those previously published using other segmentation algorithms on CT (Met_1 [Thörnqvist, Acta Oncol, 2010], Met_2 [Acosta, Prostate Cancer Imaging, 2010] and Met_3 [Huyskens, Radiother & Oncol, 2009]), and MRI (Met_4 [Dowling, Prostate Cancer Imaging, 2010]).

Results: The segmentation of all OARs took about five minutes per patient. For both image modalities and the 3 OARs, the DI increased with *K* to reach a plateau at *K*=300 for MRI and *K*=500 for CT. Under these conditions, the results were DI_{MRI} = 82.3% ± 0.8% and DI_{CT} = 88.6% ± 2.8% for the femoral heads, DI_{MRI} = 60.8% ± 10% and DI_{CT} = 92.1% ± 3.3% for the bladder, and DI_{MRI} = 72.3% ± 6.6% and DI_{CT} = 73.8% ± 3.1% for the rectum. The worst results were obtained for the bladder on MRI images, since the radiation oncologist contoured the external side of the bladder wall and our method delineated the inner side. Our method gave good intra-user reproducibility results: DI on MRI and CT are 97.2% ± 1.8% and 93.1% ± 3.5% (femoral heads), 93.2% ± 5.5% and 93.2% ± 4.9% (bladder), and 86.8% ± 10.2% and 89% ± 10.2% (rectum), respectively. For MRI, our method gave better results than Met_4 using an atlas, for the segmentation of rectum, but not for segmentation of femoral heads and bladder with $DI_{MRI}(Met_4)$ values of 89.0% ± 1.0% (femoral heads), 64.0% ± 18% (bladder), and 65.0% ± 2.0% (rectum). On CT images, our method consistently yielded the best results when compared with the 3 other methods ($Met_{1,2,3}$).

Conclusions: Our method based on superpixels provides an interactive, fast and efficient segmentation of male pelvis OARs on MRI and CT. A future work will be to use the segmented bladder and rectum to automatically delineate the prostate.

Poster: Physics track: Imaging: focus on QA and technical aspects

PO-0972

Geometric verification of Dynamic Wave Arc using orthogonal X-ray fluoroscopic imaging

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Purpose/Objective: To describe an independent methodology of determining Gantry/Ring angular positions using the on-board orthogonal fluoroscopy system of the Vero machine. The method was applied to determine the