ABSTRACT FINAL ID: 2088;

TITLE:
A Prospective Comparison Study of Liver Tumour Target Definition Based on Triphasic CT and Gadolinium MR

AUTHORS (ALL): Voroney, Jon-Paul Josef[1]; Brock, Kristy [3]; Eccles, Cynthia [3]; Haider, Masoom [2]; Dawson, Laura [1].

INSTITUTIONS (ALL): 1. Radiation Oncology, Princess Margaret Hospital, Toronto, ON, Canada.
2. Radiology, Princess Margaret Hospital, Toronto, ON, Canada.
3. Radiation Medicine, Princess Margaret Hospital, Toronto, ON, Canada.

ABSTRACT BODY:

Purpose/Objective: To quantitatively compare liver cancer gross tumour volume (GTV) defined using MR and triphasic CT.

Materials/Methods: Diagnostic quality planning MR scans with and without gadolinium (6-8 mm slice thickness) and triphasic planning CT scans (2-5 mm slice thickness) were obtained in twenty-three patients with non-resectable cholangiocarcinoma (n=4), hepatoma (n=10) and liver metastases (n=9) enrolled on a protocol of hypofractionated highly conformal radiotherapy. The liver was immobilized in exhale treatment position, using the active breathing coordinator for CT and voluntary breath hold for MR. On the CT and MR series best demonstrating the tumor, the liver and GTV were contoured with tools from Pinnacle (v6.5) treatment planning software. Anatomical reference points within the liver were identified. Despite careful patient positioning, spatial changes in liver position occured between CT and MR imaging. A deformable registration method based on finite element modeling accounting for biomechanical forces and resulting positional and volumetric changes was used to register the CT and MR livers and resolve geometric differences between them. Accuracy of registration of anatomical reference points was calculated, and spatial differences between the CT and MR GTVs were then quantified using the same deformable registration technique to register the CT and MR GTVs.

Results: The contrast CT best visualizing the GTV was the arterial phase CT for hepatoma (7/11) and the venous phase CT for metastases (7/9) and cholangiocarcinoma (4/4); the MR sequence best visualizing the GTV was gadolinium enhanced T1 weighted MR (22/24) and dual echo MR (2/24). Additional tumour foci were seen with MR in 3 cases. Following deformable registration of the liver volumes to resolve geometric discrepancies of the liver, the average vector magnitude (VM) of the residual registration error based on the displacement of the registered anatomical references points was 4.2 mm (SD = 1.7 mm), less than the MR slice thickness. The average CT and MR GTVs was 289 cc (range: 9-1467 cc) and 278 cc (range: 6-1731 cc) respectively. The average difference in CT and MR GTV was 11 cc (range: 1-263 cc), with CT GTV larger then MR GTV in 3/7 metastases, 4/4 cholangiocarcinomas and 6/11 hepatomas. The average ratio of CT/MR GTV was 1.2 (range: 0.3-4.2).
Deformable registration of the MR GTV to the CT GTV revealed substantial spatial differences. The study population mean of the average distance between the CT and MR GTV surfaces was 2.8, 2.9 and 2.9 mm in the medial-lateral (ML), anterior-posterior (AP) and cranial-caudal (CC) directions, with a standard deviation of 2.0, 2.9 and 2.1 mm. The study population mean of the maximal distance between CT and MR GTV surfaces was 17.6, 17.9 and 16.6, with maximal distances between individual surfaces as high as 39.7, 63.8 and 42.4 in the ML, AP and CC directions. The average percentage of GTV surface area that differed by 3 mm or more, 5 mm or more and 15 mm or more was 56% (max 92%), 35% (max 86%) and 9% (max 56%).

Conclusions: MR defined GTVs can be significantly different than CT defined GTVs and this should be considered for high precision liver cancer radiotherapy.

	Number	Av SA Δ (mm)		% SA Δ				
	ML	AP	CC	VM	≥ 3 mm	≥ 5 mm	≥ 15 mm	
H	10	2.1	2.2	2.9	7,3	60	38	7
CC	4	3.7	4.9	3.0	8.1	62	38	15
LM	9	2.1	2.2	2.3	4.5	48	28	5
Total	23	2.8	2.9	2.9	5.9	56	35	9

Average (Av) surface area (SA) difference (Δ) statistics between MR and CT defined GTVs by tumour type, hepatoma (H), cholangiocarcinoma (CC) and liver metastases (LM).

(No Image Selected)