Multi-Modality Imaging Reduces Intra-Observer Variability in GTV Delineation of Sarcomas and Chordomas

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INTRODUCTION

Sarcomas constitute 0.7% of cancers in adults (1). FDG-PET has been increasingly used for the diagnosis and evaluation of soft-tissue sarcomas, with regard to grading, prognostication and evaluation of treatment response (1,2). Pre- or post-operative radiation therapy has been shown to improve local control in soft-tissue sarcomas in the retroperitoneum and extremities (3). More recently, attention to metabolic tumor behavior has grown for adequate radiation dose distribution and delivery of "boost doses" to highly active areas within the delineated GTV (4). We hypothesized that using multi-imaging modalities rather than the traditional CT alone would improve the accuracy and reproducibility of GTV delineation in the treatment planning of soft-tissue sarcomas and chordomas.

AIM

We aimed at comparing inter- and intra-observer variability in GTV delineation based on CT alone, vs CT and MR, vs CT, MR, and PET, and at outlining the utility and added value PET in radiation treatment planning of sarcomas and chordomas.

METHOD

For each tumor, GTVs were drawn across 3 modality groups: CT only (group 1), CT and MR (group 2), and CT, MR, and PET (group 3) (Figure 1). Image registration was performed using MIMVista. For each group, three contouring trials were drawn at least 24 hours apart to assess intra-modality contour variability. Contouring was randomized within each group for all subjects and performed sequentially with group 1, then 2 and finally 3. 16 subjects have been included so far. Intra-observer variability was assessed in 2 ways: i. by calculating the 3D Dice score between pairs of contours, to measure the similarity between masks (higher Dice score indicates greater agreement), and ii. by calculating the Hausdorff distance, which measures distances between subsets of contours in a metric space (smaller distances indicate greater agreement). The Warfield's simultaneous truth and performance level estimation (STAPLE) method was applied to create a consensus contour from which distances are measured. Variability was then stratified by tumor size for each group.

RESULTS

In large tumors (≥12cm), no significant intra-modality contour variability was found. In tumors with a major axis <12 cm, intra-modality contour variability was significantly lower in groups 2 and 3 as compared to group 1 (pd= 0.034; ph = 0.045 and pd= 0.0024; ph=0.0061, respectively; where pd and ph are the p-values obtained by using the Dice score and the Hausdorff method respectively) (Figure 2). In 13% of subjects, distant disease was detected on PET/CT/MR that was not visible otherwise (Figure 3).

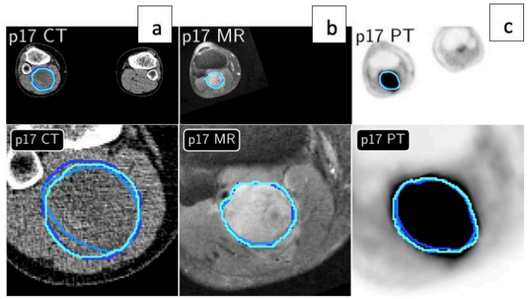

Figure 1: *Example of contours drawn for an extremity sarcoma using CT only shown on CT (a), CT and MR shown on MR (b), and CT, MR, and PET shown on PET (c). Less contour variability is noted in groups 2 (b) and 3 (c) with respect to group 1 (a).*

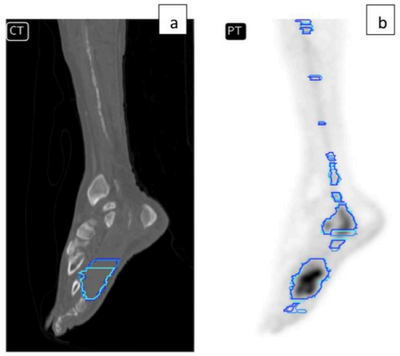

Figure 3: *Sagittal view of GTV contours drawn using CT alone (a) and using CT, MR, and PET (b). Distant spread from a primary tumor in the foot is only seen on PET.*

RESULTS

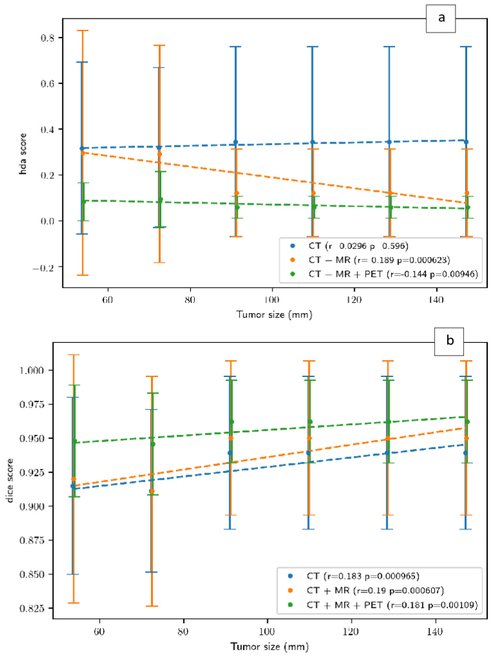

Figure 2: *Dice score (a) and Hausdorff distance (b) as a function of tumor size across each group. Multimodality imaging as compared to CT alone seems to significantly reduce variability for smaller tumors (<12 cm).*

CONCLUSIONS

Multi-modality GTV delineation of sarcomas and chordomas provided valuable reduction in variability in the challenging case of small lesions but did not significantly improve performance in larger tumors.

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