EVALUATION OF GRADIENT PET SEGMENTATION FOR TOTAL LESION GLYCOLYSIS COMPARED TO THRESHOLDS AND MANUAL CONTOURING

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Purpose & Objectives

Assessing response to therapy or prognosis using SUVmax has a number of limitations including the sensitivity of SUVmax to noise. Total lesion glycolysis (TLG) is less sensitive to noise and incorporates both size and activity (SUVmean x volume) into one measure. TLG has been shown to have value in both determining prognosis and response to therapy[1-4]. TLG has taken on additional importance as a parameter that can be measured as part of the PERCIST 1.0 guidelines[5].

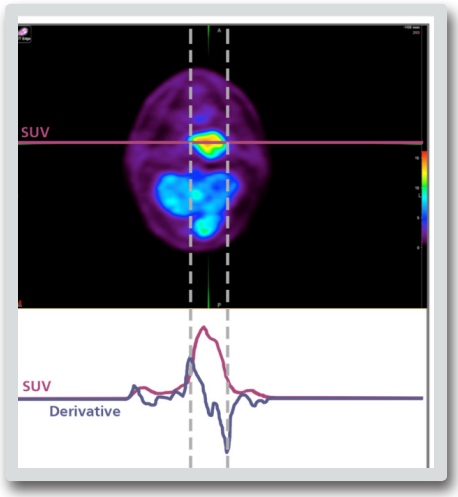
Accuracy of PET segmentation is important for TLG since it utilizes volume. Previously we demonstrated the superior volumetric accuracy of a gradient PET segmentation method (GRAD) compared to SUV thresholds (THRESH) in sphere phantoms[6] and clinical lung cancer patients using maximal pathological diameter for comparison[7] and compared to THRESH and manual contouring (MC) using realistic Monte Carlo simulated PET scans of the thorax[8]. In this study we evaluated the effect of segmentation accuracy on TLG.

Methods & Materials

Thirty-one lung tumors of varying size, shape, and location were segmented by 7 clinicians on 25 realistic digital PET scans of the thorax[9]. GRAD, THRESH and MC methods were used. GRAD identifies tumor edges based on a change in count levels at the tumor border. THRESH was performed using 25-50% of maximum counts at 5% increments. Accuracy and bias were measured by calculating the mean absolute % error and mean % errors respectively (abs%error and %error) for TLG using all methods.

Figure 1

Spatial Derivative



Results

GRAD was the most accurate technique with abs%error of 6.1 (10.3 SD). Both 25% THRESH, the most accurate threshold, and MC were significantly less accurate with abs%error of 10.2 (19.1) and 14.5 (19.2) respectively ($p < 0.0013$). 25% THRESH had the smallest bias with %error of -1.1 (21.6) followed by GRAD with -3.8 (11.4), however, the difference was not significant ($p = 0.13$).

Table 1

Accuracy (Total Lesion Glycolysis)

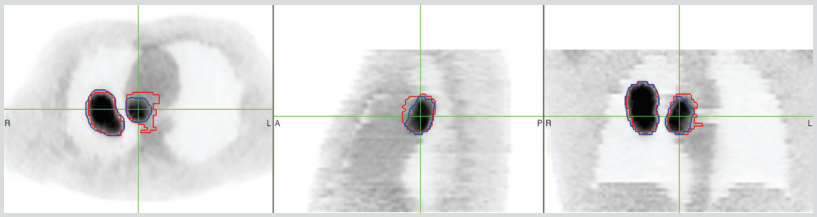
	MC	GRAD	25%	30%	35%	40%	50%	Mean
Average Absolute % Error	14.50	6.15	10.23	13.14	16.38	22.50	37.18	17.5
Standard Deviation	19.16	10.32	19.09	15.87	11.12	15.18	14.06	

p-values

PET vs 25% THRESH	GRAD vs MC
0.0013	0.0000000014

Figure 2

Digital PET Phantom - NSCLC



For cases where the tumor is in the center of lung (i.e. high source-to-background) and fairly homogeneous, 25% THRESH performs fairly well, however, in the mediastinum with lower source-to-background 25% THRESH performs poorly. GRAD produces more accurate segmentations in both of these scenarios.

Conclusions

GRAD resulted in significantly more accurate TLG calculations than the other contouring methods. GRAD has the potential to play an important role in both determining prognosis and assessing response to therapy.

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