Assessment of Ventilation-Perfusion (V/Q) Relationships with ^{68}Ga V/Q PET/CT in Lung Cancer Patients

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INTRODUCTION

- Currently, the application of standard pulmonary function tests (PFTs) for lung cancer patients only provide information relating to global lung functions (1).
- Diffusing capacity for carbon monoxide (DL_{CO}) is one of the metrics generated from PFT that approximate the ease of gas diffusion in the lungs.
- In a recent clinical trial, Le Roux et al. developed a novel pulmonary functional imaging protocol using ^{68}Ga-Galligas and ^{68}Ga-macroaggregated albumin (MAA) to assess ventilation (V) and perfusion (Q) performance respectively, in combination with 4D-CT (1).
- Local lung function characterization has the potential to aid radiation therapy planning and toxicity avoidance in radiation oncology.

AIM

To quantify:

- Accuracy of ^{68}Ga-Galligas/^{68}Ga-macroaggregated albumin (MAA) PET/CT to assess regional ventilation/perfusion (V/Q) matching by comparison with pulmonary function test (PFT) results;
- Correlations between V and Q images, in patients with lung cancer.

METHOD

- End-exhalation phase images of 30 patients from a clinical trial were acquired, and patients with missing 4D PET/CT, missing PFT, or substantially low ^{68}Ga signal in the lungs were excluded from the analysis.
- Images were processed to correct for residual activity before analysis following the workflow illustrated in figure 1.
- log(V/Q) of each voxel was calculated to quantify V-Q mismatch, with 0 meaning no mismatch and increasing deviation from 0 meaning increasing mismatch.
- Percentages of voxels with log(V/Q) values within eight cutoff deviations from 0 (between 0.05-0.4) were calculated to quantify the extent of V-Q mismatch.
- Abovementioned percentages were correlated with DL_{CO}.
- Voxel-wise Spearman's rank correlation coefficients between V and Q were calculated.

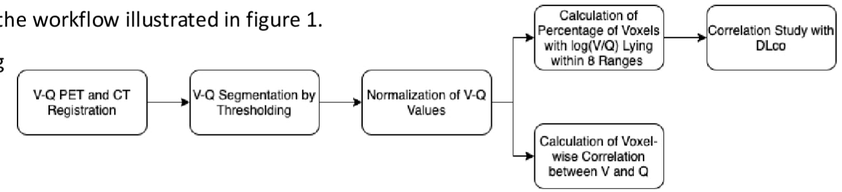

Figure 1: Analysis Flowchart

RESULT

- 19 evaluable patients were analyzed.
- The cutoff deviation of 0.25 (Fig. 2) showed the highest correlation (0.59, P<0.01)
- Spearman's rank correlation coefficient and p-value of 8 deviation ranges are shown in table 1.
- Voxel-wise correlation between V and Q varied widely between patients (range: 0.20 – 0.82).
- Representative patient with the largest and smallest voxel-wise Spearman's rank correlation between V and Q images are shown in figure 3.

	Spearman's Rank Correlation Coefficient	P-value
0.05	0.449	0.054
0.10	0.549	0.015
0.15	0.569	0.011
0.20	0.577	0.010
0.25	0.591	0.008
0.30	0.534	0.018
0.35	0.516	0.024
0.40	0.511	0.025

Table 1: Spearman's rank correlation coefficient and p-values between proportions of voxels with log(V/Q) lying within 8 cutoff ranges and DL_{CO}

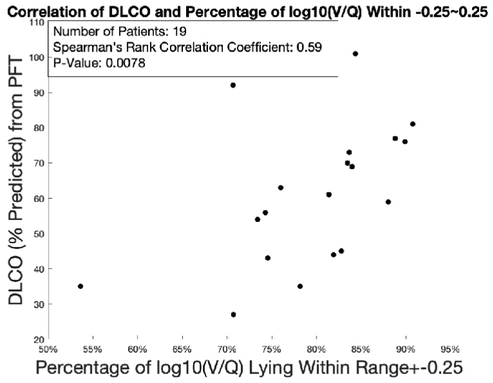

Figure 2: Proportions of voxels with log(V/Q) values lying within -0.25 to 0.25, correlated DL_{CO}. Out of 8 analyzed ranges, -0.25 to 0.25 showed the strongest correlation. Refer to Table 1 for other ranges.

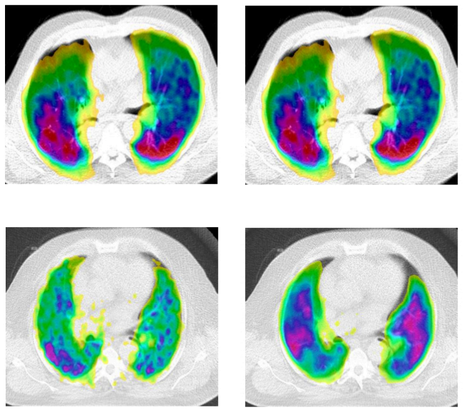

Figure 3: Patient with largest (1st row) and smallest (2nd row) voxel-wise Spearman's rank correlation coefficient between V and Q images. Left: Ventilation Image. Right: Perfusion Image. V and Q images overlaid on the end-exhalation phase of 4D-CT image.

CONCLUSIONS

^{68}Ga PET/CT-measured V/Q matching significantly correlates with PFT results, indicating its potential to provide reasonable estimates of regional gas exchange efficiency in lung cancer. The voxel-wise correlation between V and Q varied widely between patients, suggesting that V and Q may provide complementary information.

ACKNOWLEDGEMENTS

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REFERENCES

1. Le Roux P, Siva S, Steinfort D, Callahan J, Eu P, Irving L et al. Correlation of 68Ga Ventilation-Perfusion PET/CT with Pulmonary Function Test Indices for Assessing Lung Function. Journal of Nuclear Medicine. 2015;56(11):1718-1723.

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