AIM: To evaluate with experimental heterogeneous phantom the current use of PET texture analysis for heterogeneity characterization in lesions affected by respiratory motion.

INTRODUCTION

- An increasing interest is focusing on intratumoral FDG heterogeneity characterization by image features (IF) for its use in prognosis and monitoring of radiotherapy treatment response.
- In lung cancer, quantification by PET/CT imaging presents additional challenges due to respiratory movement.

Could the compensation of motion implied by 4D PET/CT minimize the variability of image features in lesions following different movements?

MATERIALS & METHODS

- Experimental phantom measurements
  - Heterogeneous (COV>0.3) phantoms of alginate [1] and lV-FDG on image.
  - Respiratory movement [2]
- Tumor segmentation
  - PET volume (VOL₄₀₀₄₀₀₄₀₀) [3]: contouring lesions by a fixed threshold of 40% of the lesion maximum intensity.
- 4D- PET/CT acquisition
  - Philips System GEMINI TT TOF (64)
  - PET and CT acquisitions synchronized to the breathing cycle.
  - Pressure sensor belt: Mayo Clinic Respiratory Feedback Monitor.
  - Data processing results in 10 phases.
  - 10 min (PET) and 36 s (CT)
  - 2 iterations & 3 subsets
  - Image voxel volumes
    - CT: 1.17x1.17x3 mm³
    - PET: 4x4x4 mm³

RESULTS

- Comparison of IF derived from 3D-PET (IF³) with respect to values derived from 4D-PET (IF⁴).
  - Relative deviation (δ)=[|IF₃−IF₄|/IF₄]x10²
- Comparison of IF variability for different movements with 3D-PET and with 4D-PET.
  - Our set-up permitted to study the effect of the three main characteristics of respiratory movement on heterogeneity quantification: amplitude along SI, hysteresis along U₂, and waveform. IF values derived from G- and U-image were analyzed in terms of linear correlations (LC) for 10 possible combinations of the 5 movements applied to the phantoms in each study.
  - Wilcoxon Signed Rank test showed significant differences for Cmax, volume, COV and WH.
  - Overall, ideal performance, i.e. significant LC for all pairs of movements (30/30), was obtained for:
    - WH on U-image and
    - WH, ENG, LH and ENT on G-image.
  - For a given waveform, to increase the amplitude along SI did not translate in significant differences between IF variability on G- and U-image.
  - Hysteresis did not compromised variability on U-image, but for G-quantification by first order IF (FOS) poorer variability was observed.
  - For different waveforms, U-image quantification had poor correlation for IF, both 1st and 2nd order. This effect was minimized using G-image.

CONCLUSIONS

- This work presented the first evaluation of the impact of motion in IF variability with heterogeneous experimental phantoms.
- For some IF, the use of 4D-PET instead of 3D-PET for IF computation would not translate to a significant difference on their values. However, the use 4D-PET for IF computation should be recommended in order to minimize IF variability in lesions following different movements.

REFERENCES