Estimating the Dosimetric Impact of Patient Anatomy Changes with In-Vivo EPID Images, Using the Gradient Dose Segmented Analysis Technique

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INTRODUCTION

- In-vivo EPID images can be used to detect large errors and changes in patient anatomy (1)
- However, there is no clear metric that quantitatively estimates the dosimetric effect of anatomy changes.
- Efforts to link in-vivo gamma metrics to dosimetric impacts have shown correlations that are highly dependent on treatment site and dose comparison techniques (2).

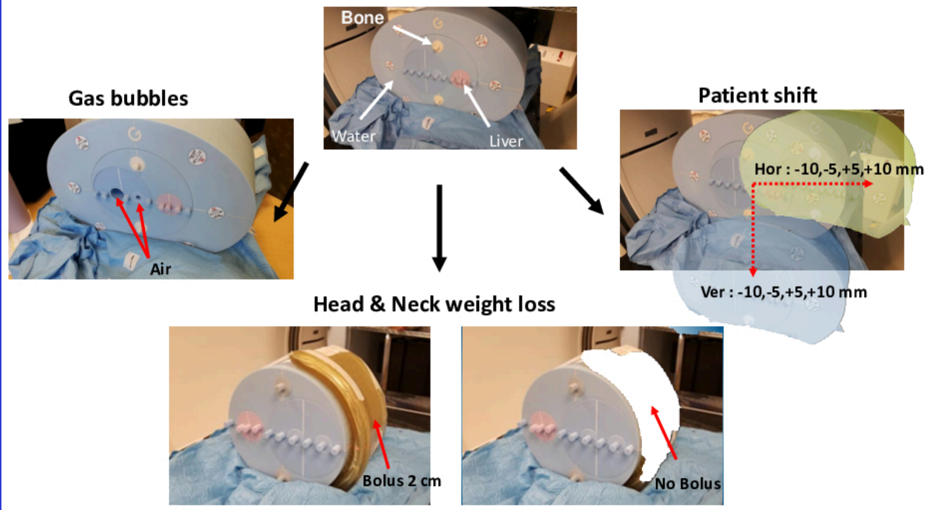
•AIM

- We propose a metric to directly give a quantitative estimate of the change in PTV mean due to patient anatomy changes.

METHOD

- EPID images in this study were acquired on a Varian Halcyon.
- A phantom was used to simulate anatomical changes (i.e. patient shifts, gas bubbles, head and neck weight loss and a limb in the treatment field).
- The change in the PTV mean was simulated in the Eclipse TPS.

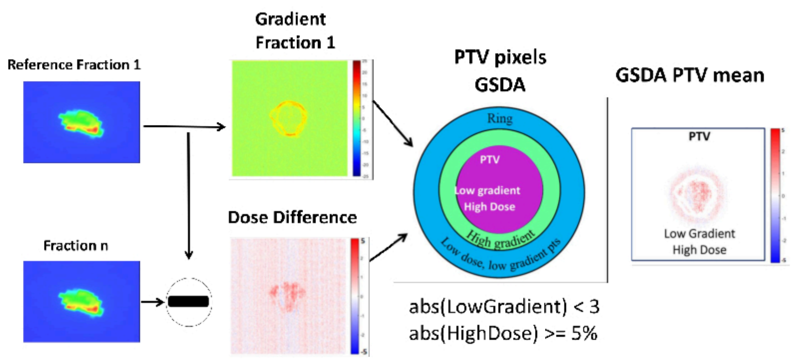
GAMMEX: Cone-Beam CT Electron Density



METHOD

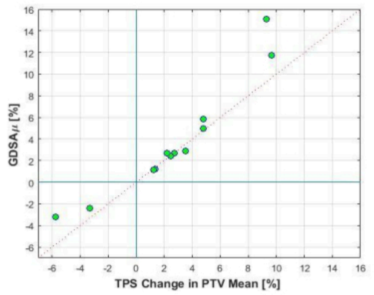
- IMRT and VMAT treatment plans were delivered to the phantom with and without the anatomy changes. In-vivo EPID images were recorded and analysed using the images taken with no errors as the reference.
- The gradient dose segmented analysis (GDSA) technique was used. Gradient and dose thresholds are used to select the high-dose, low-gradient region of an in-vivo image. The mean of this region is then calculated ($GDSA_{\mu}$).

Gradient Dose Segmented Analysis (GDSA)

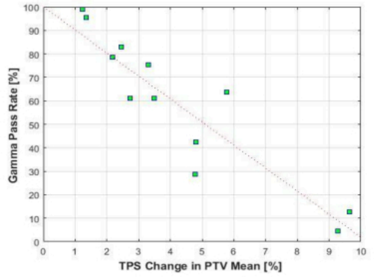


- The gamma approach was also investigated.
- Parameters in the GDSA and gamma approaches were tuned using phantom data to maximize the R^2 between the change in TPS PTV mean and the
  1. $GDSA_{\mu}$
  2. Gamma pass rate

$GDSA_{\mu}$ from the transit EPID images versus the change in PTV mean from phantom studies for simulated weight loss, gas bubbles, and arm in field errors are shown. Also shown is a line with slope 1, intercept 0. $R^2 = 0.90$

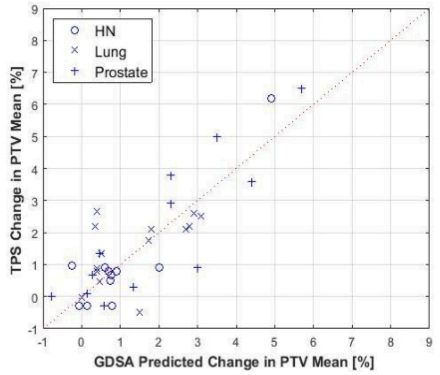


Gamma passing rates versus the change in PTV mean, for simulated weight loss, gas bubbles, and arm in field. Criteria is 3%/3mm, 45% lower threshold. Also shown is the linear fit, fixing the y-intercept at 100%. $R^2 = 0.84$



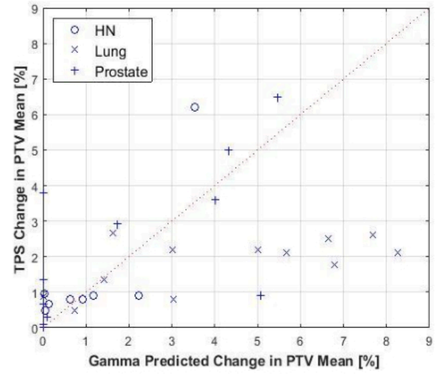
RESULTS

- The GDSA and gamma approaches were applied to patient data. Patient's that underwent a re-CT were investigated. Using the re-simulation to estimate the change in the PTV mean (11 HN, 14 Lung, 12 prostate patients). All patient images were compared to the first fraction of treatment



Change in PTV mean measured in the TPS versus change in PTV mean predicted from *GDSA*$_{\mu}$, for 11 HN, 14 Lung, 12 prostate patients. Also shown is a line with slope 1, intercept 0.

- The $GDSA_{\mu}$ was able to predict the change in PTV mean to 0.09 ± 0.98 % ($R^2 = 0.68$)
- For the gamma approach the linear model found from the phantom data was used to predict the change in the PTV mean for patients.



Change in PTV mean measured in the TPS versus change in PTV mean predicted from the gamma pass rate from the transit EPID images, for 11 HN, 14 Lung, 12 prostate patients. Also shown is a line with slope 1, intercept 0.

- The gamma pass rate was able to predict the change in PTV mean to -0.65 ± 2.21 % (R^2 =0.26). Lung patients had the largest deviation.

CONCLUSIONS

- Both the $GDSA_{\mu}$ and gamma pass rate were used to make predictions in the change in the PTV mean using in-vivo EPID images.
- The $GDSA_{\mu}$ strongly correlates with changes in the PTV mean dose and was able to predict the change in the PTV mean to less than 1%.
- The relationship between the change in PTV mean and gamma pass rate was found using phantom data and used to estimate the change in PTV mean in patient data.
- The gamma pass rate was able to predict the change in PTV mean to 2.2% or less.

REFERENCES

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