

EVALUATION OF PLANNING TARGET VOLUME (PTV) MARGIN FOR 4DCT-BASED LUNG SBRT UNDER FREE BREATHING: A SINGLE-CENTRE STUDY

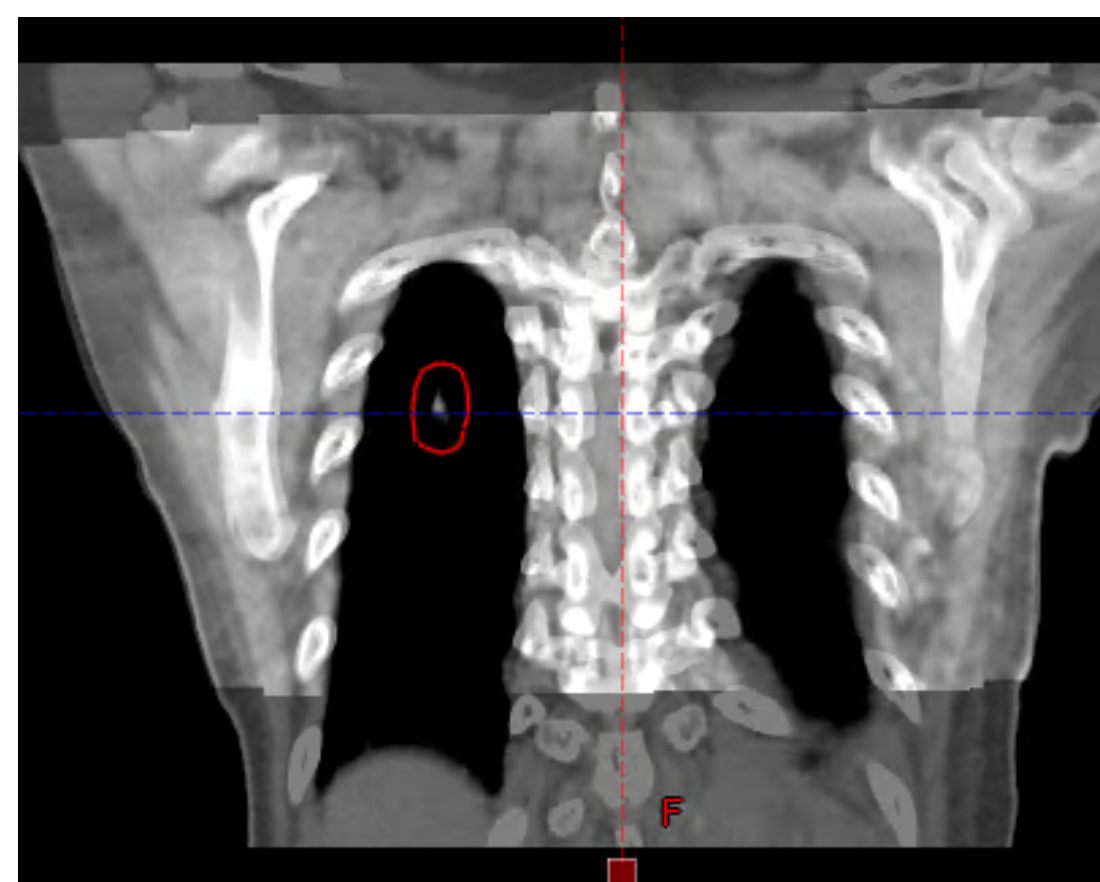
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BACKGROUND

Respiratory motion can affect the accuracy of lung stereotactic body radiotherapy (SBRT) treatment. Although four-dimensional computed tomography (4DCT) helps assess tumour motion and improve target definition, uncertainties related to breathing variation, patient positioning, and movement during treatment still remain. Determining an appropriate PTV margin is therefore essential to achieve reliable target coverage while limiting dose to surrounding healthy lung tissue. Underestimation of PTV margin will risk missing the target, whereas overestimation of PTV margin will increase the normal lung dose.

METHODOLOGY

- A retrospective study
- 17 patients (21 samples) from 2024 to 2025 Single lesion lung SBRT 5 fractions using 4DCT scan (only upper or middle lung lobes)



Obtain anterior-posterior (AP), superior-inferior (SI) and lateral (RL) couch shift during pre- and mid- treatment CBCT for each fraction

VAN HERK MARGIN RECIPE

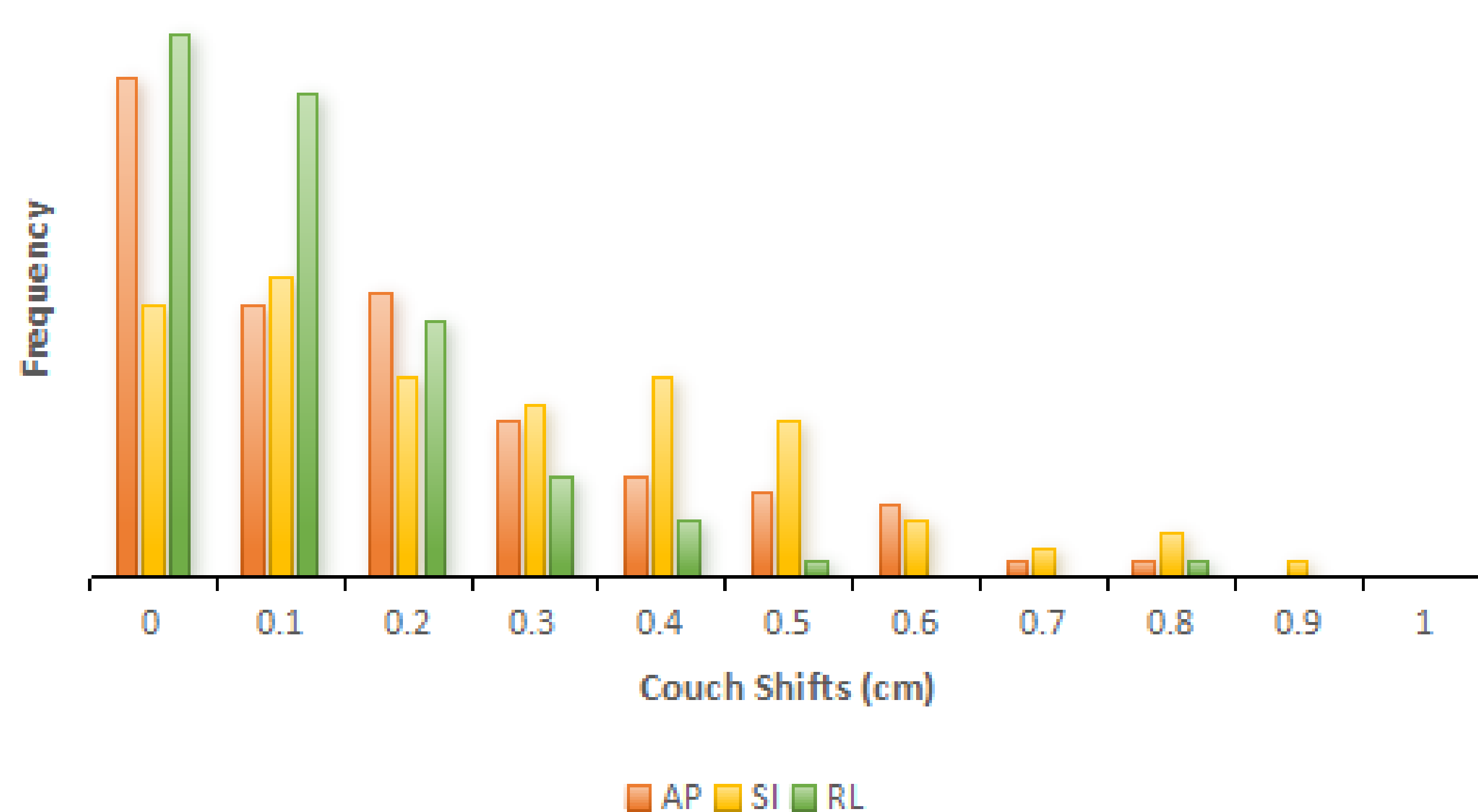
$$PTV\ margin = 2.5 \Sigma + 0.7 \sigma$$

$$\Sigma_T = \sqrt{\Sigma^2 + \Sigma_s^2}$$

Σ Systematic error: standard deviation around the group mean error
 σ Random error: Root mean square of the patients' standard deviation.
 Σ_s : Systematic error that considered the setup error in margin calculation/delineation (1mm)

	# kVCBCT_05k01	# kVCBCT_05l01
Status	★	★
Vrt [cm]	+0.09	+0.05
Lng [cm]	+0.08	-0.10
Lat [cm]	-0.25	-0.05

RESULTS



$$Percentage = \frac{No. of\ fractions\ shift\ less\ than\ 0.3cm}{Total\ fractions} \times 100$$

61%

AP couch shift < 0.3cm

47%

SI couch shift < 0.3cm

83%

RL couch shift < 0.3cm

The calculated mPTV margins were 0.9cm ± 0.3 (AP), 1.2cm ± 0.38 (SI) and 0.7cm ± 0.23(RL).

- Greater motion variability in the SI direction.
- RL direction demonstrated the highest positional reproducibility.
- These results suggest a non-isotropic margin to be considered.

CONCLUSION

This study evaluated residual mPTV requirements for lung SBRT planned using 4DCT under free-breathing conditions. The results demonstrate direction-dependent motion variability and support the consideration of non-isotropic PTV margins, to improve target coverage while minimizing radiation exposure to surrounding organs at risk.

References

Fu W;Zhang Y;Mehta K;Chen A;Musunuru HB;Pucci P;Kubis J;Huq MS; (2024, May 8). Evaluating intra-fractional tumor motion in lung stereotactic radiotherapy with deep inspiration breath-hold. Journal of applied clinical medical physics. <https://pubmed.ncbi.nlm.nih.gov/38803045/>