Assessment of Lung Tumor Motion from PET/CT for Personalized Abdominal Compression Decisions in SBRT

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Purpose

Abdominal compression is commonly employed in lung SBRT to reduce respiratory-induced tumor motion. By limiting diaphragmatic excursion, abdominal compression can decrease the magnitude of tumor displacement during breathing, thereby reducing ITV volume and minimizing radiation to surrounding healthy tissues. However, the effectiveness of abdominal compression is highly patient dependent, with some patients experiencing substantial motion reduction while others show little improvement or even increased motion. In addition, the use of compression may introduce patient discomfort, difficulty maintaining reproducible positioning, or altered breathing patterns that can compromise treatment tolerability and workflow efficiency. Consequently, a reliable method for identifying patients who are most likely to benefit from abdominal compression would improve individualized treatment planning and patient management in lung SBRT.

PET/CT, routinely acquired for lung cancer staging, provides complementary anatomical and functional imaging information. The CT component offers high-resolution structural detail, while the PET component reflects metabolically active tumor regions averaged over multiple respiratory cycles during image acquisition. Because PET acquisition occurs over an extended time period, respiratory motion can produce characteristic image blurring, elongation, and displacement of the tumor signal. Quantitative PET/CT-derived motion metrics may therefore serve as surrogate indicators of respiratory motion without requiring additional imaging procedures.

This study investigates whether motion information extracted from PET/CT images can be used to guide patient-specific decisions regarding the application of abdominal compression in lung SBRT.

Materials and Methods

A total of 110 patients treated with lung SBRT who underwent both PET/CT and 4DCT imaging were retrospectively included. Tumor motion magnitudes derived from PET/CT images were quantitatively compared with motion measurements obtained from 4DCT, which served as the reference standard for respiratory motion assessment. Motion estimates were evaluated separately in the left–right (LR), anterior–posterior (AP), and superior–inferior (SI) directions, as well as using the combined three-dimensional motion vector. PET/CT-based motion metrics were extracted by analyzing motion-induced tumor blurring and displacement patterns observed on the PET images. Correlation analyses were performed to assess the agreement between PET/CT-derived and 4DCT-derived motion measurements in each directional component and in overall motion magnitude.

Results and Discussion

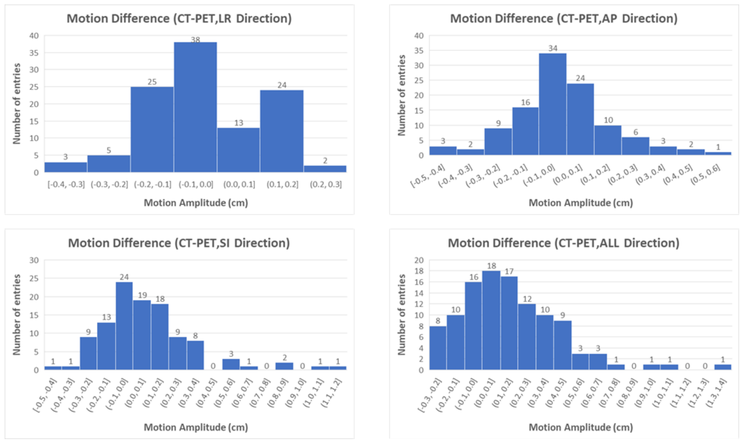

Figure 1: Distribution of motion differences between 4DCT and CT/PET in left-right, anterior-posterior, superior-inferior , and combined directions.

	LR	AP	SI	Combined
Within 3mm	97.3%	90.0%	83.6%	73.6%
Within 4mm	100.0%	94.5%	91.8%	82.7%
Within 5mm	100.0%	99.1%	92.7%	90.9%

Table 1: Percentage of patients showing motion differences between 4DCT and CT/PET in left-right, anterior-posterior, superior-inferior , and combined directions.

4DCT and CT/PET motion differences were centered near zero across all directions, indicating good agreement. LR differences were tightly clustered within ±0.2 cm; AP differences showed a slightly wider spread but largely remained within ±0.3 cm. SI differences were more variable, with some exceeding 0.5 cm, reflecting dominant respiratory motion. Overall combined differences were small (<0.3–0.4 cm) for most cases. Agreement was highest in LR (97.3% within 3 mm, 100% within 4 mm) and AP (90% within 3 mm, 99.1% within 5 mm). SI agreement was lower (83.6% within 3 mm, 92.7% within 5 mm), consistent with greater motion along this axis. When all directions were combined, 73.6% of cases agreed within 3 mm, 82.7% within 4 mm, and 90.9% within 5 mm.

Conclusions

PET/CT-derived tumor motion shows strong agreement with 4DCT and may provide a practical, patient-specific tool to determine the necessity of abdominal compression in lung SBRT using imaging already acquired in routine care.

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