2026 JULY 19–22 VANCOUVER, BC
JOINT AAPM | COMP MEETING

Application of Surface-Guided Radiotherapy (SGRT) Combined with Cone-Beam CT (CBCT) In Lung Stereotactic Body Radiotherapy (SBRT)

Yanyan Shi[1], Weiwei Sang[1], Bin Wang[1], Xuemei Feng[1] and Lihua Zhang, MD,PhD[1]
[1]Shanghai Jiahui International Hospital, Radiation Oncology Department, Shanghai, China

ABSTRACT

Purpose
To primarily evaluate setup accuracy and positioning stability of SGRT combined with CBCT in lung SBRT, with secondary assessments of target margin optimization, treatment safety, efficiency, and patient satisfaction.

Methods
A retrospective cohort included 24 lung cancer patients (14 males, 10 females; age 24–89 years, median 65 years) who underwent SGRT+CBCT-guided SBRT (2020–2025). The cohort comprised 19 single-lung-target and 5 multi-target (2–3 lesions) patients, totaling 120 fractions. All received 3000–5000 cGy/5 fractions with Wingboard + knee pad immobilization. The workflow included 4DCT-based target delineation, a 3 mm internal target volume (ITV) margin for peripheral lesions, SGRT initial positioning, CBCT verification and correction, and continuous SGRT monitoring during treatment (20–25 Hz). SPSS 26.0 was used for analyses (descriptive statistics, independent samples t-tests, and Wilcoxon tests; P value < 0.05 significant).

Results
In lung SBRT, SGRT-CBCT integration achieved excellent setup accuracy and enhanced positioning stability, with stability improving over sessions: single-target translational/rotational errors were 0.12–0.20 cm/0.32–0.38° (mean±standard deviation), while multi-target inter-target discrepancies were ≤0.08 cm/≤0.10° (P>0.05). This stability boosted efficiency, with treatment durations of 10–15 min (single-target) and 14–18 min (multi-target). All 24 patients tolerated daily irradiation without interruption, characterized by stable hematology, no grade ≥2 CTCAE adverse events, and 33.3% with self-resolving grade 1 fatigue. Dosimetrically, PTV D95 remained 97.8–98.2% for adequate coverage. Patient outcomes were favorable: 100% satisfaction and a mean Visual Analog Scale (VAS) comfort score of 8.5±1.2.

Conclusion
SGRT combined with CBCT ensures superior setup accuracy and progressively improving positioning stability with repeated sessions in lung SBRT, driving higher treatment efficiency alongside good irradiation tolerance, favorable target margin optimization, safety, and patient acceptance across subgroups, meriting widespread clinical implementation.

CONTACT

Lihua Zhang
Shanghai Jiahui International Hospital
Guiping Road, Xuhui District, Shanghai, China
E-mail:lihua.zhang@jiahui.com
Phone: +86-13764181844

INTRODUCTION

Stereotactic Body Radiation Therapy (SBRT) is a key definitive treatment for early-stage, oligometastatic, or inoperable lung tumors, with its efficacy and safety relying heavily on accurate setup and stable target positioning—challenges exacerbated by respiratory motion and thoracic anatomical complexity. Traditional cone-beam computed tomography (CBCT) enables pre-treatment positioning verification but lacks real-time monitoring, while Surface-Guided Radiation Therapy (SGRT) provides continuous intra-treatment monitoring, suggesting synergistic benefits of their integration.
However, systematic evaluations of SGRT-CBCT integration in lung SBRT, including setup accuracy, positioning stability over fractions, and impacts on target margins, efficiency, safety, and patient satisfaction, remain insufficient. This retrospective study primarily evaluated the setup accuracy and positioning stability of combined SGRT-CBCT in lung SBRT, with secondary assessments of the above outcomes, to provide evidence for its clinical application.

METHODS AND MATERIALS

This retrospective study (2020–2025) included 24 lung cancer patients (19 single-target, 5 multi-target; median age 65 years) who underwent SGRT+CBCT-guided SBRT(75 fractions for peripheral lesions, 45 for central lesions), with patients immobilized using a Wingboard + knee pad, 4DCT (10 respiratory phases) acquired for target delineation (ITV: union of GTVs across phases; PTV: ITV + 3 mm setup margin), SBRT plans optimized to deliver 3000–5000 cGy in 5 fractions with PTV D95 ≥ 97% per RTOG normal tissue constraints, a standardized treatment workflow of SGRT pre-positioning (20–25 Hz, residual error ≤1 mm) → CBCT verification/correction → SBRT delivery with continuous SGRT monitoring (paused for deviations >2 mm/1°), primary outcomes of setup accuracy and positioning stability, secondary outcomes including dose coverage, adverse events (graded per CTCAE v5.0), treatment time, patient compliance and statistical analyses performed using SPSS 26.0 with t-tests (P < 0.05 considered significant).

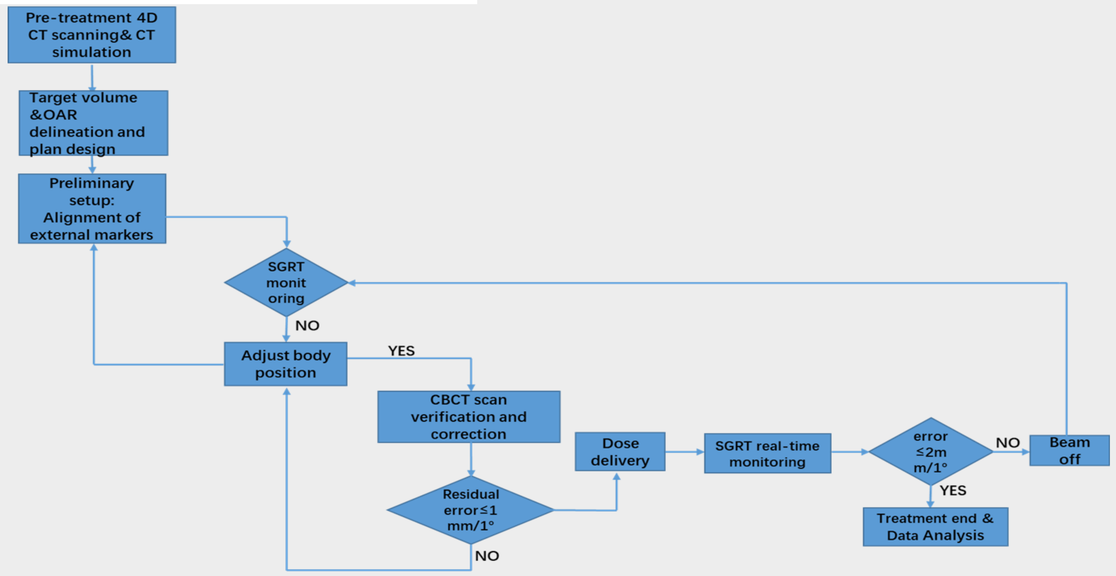

Figure 1: Overview of treatment procedure

RESULTS

Stereotactic Body Radiation Therapy (SBRT) is a key definitive treatment for early-stage, oligometastatic, or inoperable lung tumors, with its efficacy and safety relying heavily on accurate setup and stable target positioning—challenges exacerbated by respiratory motion and thoracic complexity. Traditional CBCT enables pre-treatment positioning verification but lacks real-time monitoring, while SGRT provides continuous intra-treatment monitoring, suggesting synergistic benefits. SGRT-CBCT integration in lung SBRT significantly improves setup accuracy and positioning stability: single-target translational errors were 0.12–0.20 cm and rotational errors 0.32°–0.38°, while multi-lesion (2–3 lesions) inter-target discrepancies were ≤0.08 cm and ≤0.10°, with no significant difference between early and late fractions (P > 0.05).
This approach enhanced efficiency, with treatment times of 10–15 min (single-target) and 14–18 min (multi-target). All 24 patients completed SBRT without interruption; hematologic parameters were normal, with no grade ≥1 hematologic toxicity. Grade 1 fatigue occurred in 33.3% (8/24) and resolved spontaneously, with no grade ≥2 adverse events (CTCAE v5.0). PTV D95 was 97.8%–98.2%, ensuring adequate target coverage. Patient satisfaction was 100%, with a mean VAS comfort score of 8.5 ± 1.2, attributed to SGRT's nonrestrictive, radiation-free design. However, systematic evaluations of SGRT-CBCT integration, including long-term impacts, remain insufficient. This study primarily evaluated setup accuracy and positioning stability, with secondary assessments of key outcomes, to support clinical application.

Table 1. Core Setup Error Statistics (SPSS Descriptive Analysis Results)

Error Type	Unit	Total fractions	Mean ± SD	95% Confidence Interval	P-Value	Clinical Threshold	Compliance
Vertical	cm	120	0.215 ± 0.162	0.189–0.241	0.143	≤0.3 cm	Compliant
Longitudinal	cm	120	0.125 ± 0.101	0.107–0.143	0.481	≤0.3 cm	Compliant
Lateral	cm	120	0.161 ± 0.133	0.139–0.183	0.292	≤0.3 cm	Compliant
Yaw	°	120	0.348 ± 0.322	0.299–0.397	0.025	≤1.0°	Compliant
Roll	°	120	0.381 ± 0.341	0.327–0.435	0.009	≤1.0°	Compliant
Pitch	°	120	0.345 ± 0.311	0.298–0.392	0.058	≤1.0°	Compliant

DISCUSSION

The core innovations of combining Surface-Guided Radiotherapy (SGRT) with Cone-Beam CT (CBCT) in lung Stereotactic Body Radiotherapy (SBRT) center on five pivotal aspects. First, SGRT's inherent advantages—its non-restrictive, radiation-free design—ensure patient comfort while delivering high precision and stability, with real-time monitoring (20–25 Hz) capable of capturing subtle positional shifts during treatment. Second, in internal target volume (ITV) margin optimization, a personalized 3 mm margin is established—1–2 mm narrower than the conventional 4–5 mm standard recommended by the Radiation Therapy Oncology Group (RTOG). This refinement maintains planning target volume (PTV) coverage (D95: 97.8–98.2%) while minimizing irradiation to surrounding normal tissues. Third, the SGRT-CBCT dual-modality combination outperforms single-modality guidance substantially: it constructs a "surface contour-internal anatomy" dual positioning system, controlling mean residual errors within 1 mm compared to 2–3 mm with single SGRT or CBCT alone. This resolves the longstanding mismatch between surface positioning and internal target location in traditional SBRT and eliminates the need for repeated ionizing scans. Additionally, this integrated approach facilitates the development of a standardized operating procedure (SOP), which streamlines key workflows—including patient immobilization, image acquisition, and error correction—to address inconsistencies in clinical practice. For heterogeneous clinical scenarios like multi-target tumors, the SOP incorporates stratified protocols: Multi-target patients undergo sequential CBCT verification for each lesion plus SGRT-based inter-target monitoring (ensuring inter-target deviations ≤0.08 cm). Meanwhile, the adaptive workflow—featuring consistent SGRT pre-positioning and early CBCT correction—promotes progressive stabilization of patient positioning throughout the treatment course.

CONCLUSIONS

In lung SBRT treatment, SGRT+CBCT dual-modality guidance ensures superior setup accuracy, enhanced positioning stability over fractions, improved efficiency, good radiation tolerance, optimized target margins, and strong safety/patient acceptance across subgroups—supporting widespread clinical use.

REFERENCES

1. Guo et al. (2024). SGRT-based stereotactic body radiotherapy for lung cancer setup accuracy and margin of the PTV. Journal of Applied Clinical Medical Physics, 25(3), e14195.
2. Li Q et al. Analysis of setup error and setup efficiency in SBRT for non-small cell lung cancer via a surface-guided radiation therapy system. BMC Cancer(2025).
3. Rudat et al. (2023). Setup accuracy and margins for surface-guided radiotherapy (SGRT) of head, thorax, abdomen, and pelvic target volumes. Scientific Reports, 13(1), 17018.

© Poster Template by Genigraphics® 1.800.790.4001 www.genigraphics.com