Respiratory motion pattern analysis of lung cancer patient with gated treatment: A preliminary study

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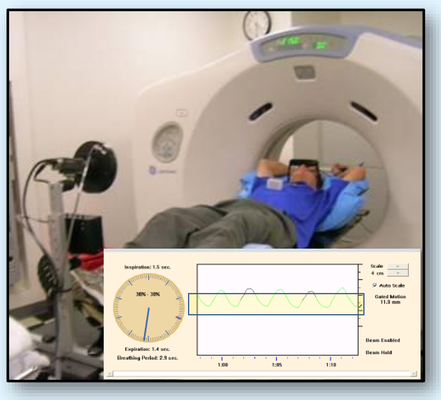
Introduction



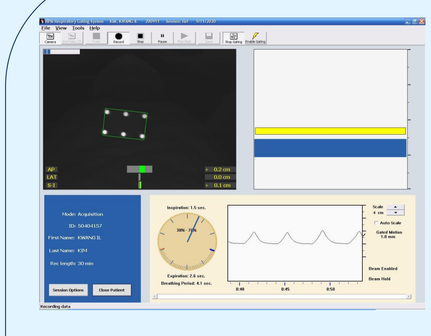
- Real-time Position Management (RPM) system is used to trace movement of surrogate during CT simulation and gated radiation treatment.
- An external surrogate, represent respiratory tumor motion, based respiratory gating technique is a useful method for the treatment of a moving lung tumor.
- The success of gated radiation treatment technique relies on the repeatability of the respiratory motion.

Objective

- Analyze external surrogate movements records during CT simulation and treatment to investigate respiratory pattern of lung cancer patient with gated radiation therapy.
- Select patients who need additional breathing training to achieve successful gated radiation treatment.

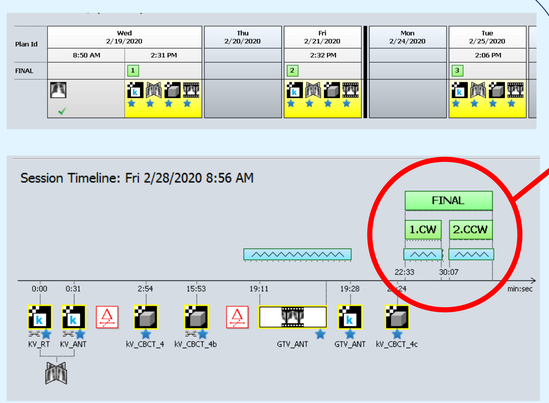
Materials & Methods

4D CT acquisition & Treatment planning → **Treatment** → **Export waveform** → **Analysis**

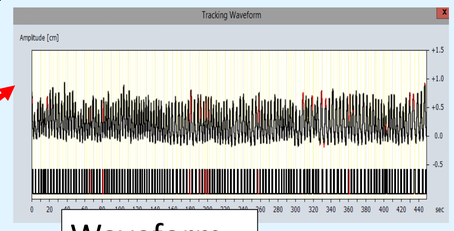


- CT simulation is performed using 4D CT technique to reduce motion artifacts . (RPM, Varian)

- Based on planning 4D CT, treatment plan was established using gating technique.



- All treatment records were recorded on ARIA oncology information system including respiratory motion as waveform.



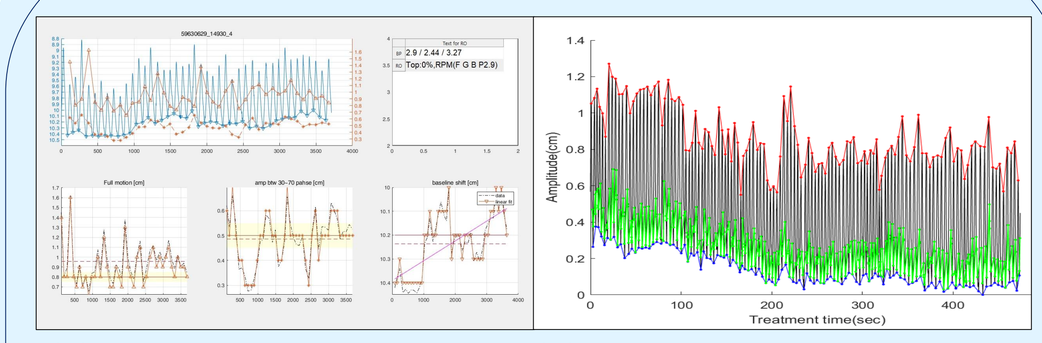
Waveform

Patient ID
Treatment technique
Treatment time
Amplitude of surrogate
- left-right,
- Anterior-posterior,
- Superior-inferior

Phase information
Beam on/OFF

- Respiratory records (CT simulation and treatment) of 14 Lung cancer patient with phase gated SBRT technique was randomly enrolled.
- Respiratory patterns of each patients were analyzed using surrogate movement records. (*.vxp and waveform which contain surrogate motion during CT simulation and every treatment fraction.)

Results and Summary

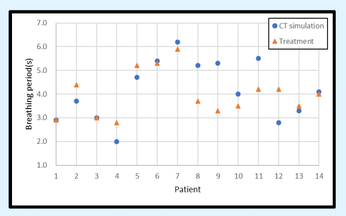


(a) Respiratory pattern analysis during 4D CT simulation(*.vxp)

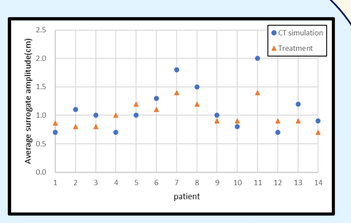
(b) Respiratory pattern analysis during treatment(waveform)

- (a), (b) shows respiratory pattern analysis results from 4D CT simulation and every treatment fraction.
- (a) shows 0-90%, 30-70% phase gating motion and baseline shift during 4D CT simulation.
- (b) shows 0-90%, planned gating threshold and baseline shift during actual treatment with gated SBRT.

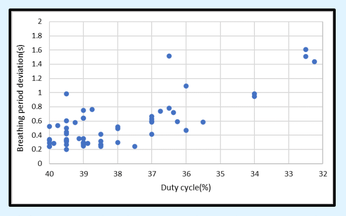
Respiratory pattern analysis	
Enrolled lung patient	14 gated SBRT Patients
Average treatment time including patient set-up	1339 second (±306)
Average treatment time excluding patient set-up	583 second (±130)
Average baseline shift	1.5 mm (±0.5)
Average duty cycle (treatment/plan)	95.8%



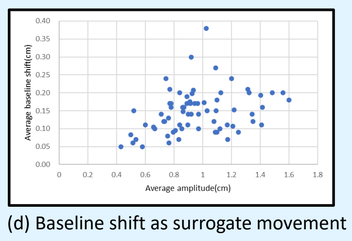
(a) Average breathing period



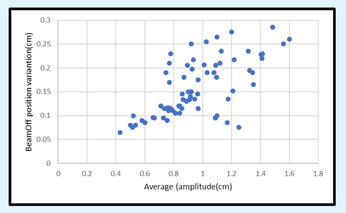
(b) Surrogate movement with full breathing



(c) Duty cycle change as breathing period



(d) Baseline shift as surrogate movement



(e) Respiratory pattern analysis

(a), (b) shows average breathing period and surrogate movement with full breathing during CT simulation(blue circle) and treatment(orange triangle). Average breathing period and amplitude were almost similar between CT simulation and treatment.

(c) Shows the duty cycle(beam on time/treatment time), which affects treatment time and condition of LINAC, was decreased when the breathing period deviation is large.

(d), (e) shows average baseline shift and beam-off position of surrogate as breathing amplitude. It shows when the breathing amplitude bigger, the variation of baseline shift and beam-on/off position is bigger.

Conclusion

- This study is the first step of analyzing respiratory patterns of patient who receive gated RT technique.
- Analyzed respiratory pattern data of lung cancer with gated radiation treatment during CT simulation and treatment potentially provide the necessity of additional breathing education during treatment.
- For the next step, the actual tumor motion during patient treatment with gated RT will be studied with correlation of surrogate motion and actual tumor motion. These tumor motion data will be used to verifying exposed dose to the tumor with gated RT technique.

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