Impact of Respiratory Motion Management Selection on Success Rate of Non-Small-Cell Lung Cancer (NSCLC) Stereotactic Body Radiation Therapy (SBRT) Protocol At Roswell Park Comprehensive Cancer Center (RPCCC)

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Introduction

The use of SBRT for NSCLC is being examined on protocol I1307721, a single site study out of RPCCC - an adaptation of RTOG protocol 0816. Over 700 patients have been treated on this study resulting in approximately 50 failure cases. It was hypothesized that due to the nature of SBRT, motion management related concerns may be impacting the success rate of the protocol. The current study aims to examine a variety of elements about the plans created as part of the I130772 protocol to determine their relationship to protocol success rate.

Methods and Data Analysis

For all patients on the study, the primary element examined was motion management strategy. Other plan metrics that were examined and their definitions are as follows:

- Lesion Location (Loc)
  - RUL, RML, RLL, LUL, LLL
- GTV Degree of Motion (RoM)
  - Difference between the position at a given phase and phase 50 was evaluated using a 3D distance formula
- Planning Algorithm
  - Acuros, AAA
- Treatment Technique
  - 3DCRT, VMAT
- Number of Small Apertures (SAS)
  - Number of open MLC pairs with a gap under 4mm over total number of open MLC pairs for given aperture

- Conformity Index (CI)
  - Volume of 100% isodose line over PTV volume
- Gradient Index (GI)
  - Volume of 50% isodose line over volume of 100% isodose line
- PTV Coverage
  - Percent PTV covered by 90% isodose (PTV90)
  - Percent PTV covered by 100% isodose (PTV100)
- Target Size (cc) (TS)
- Prescription Dose (cGy)
- Modulation Factor
  - MU delivered over prescription dose (MU/Gy)

Results

Results were collected for overall success rate and the metrics seen to be most closely associated with success rate by t-test completion for all analyzed cases were PTV100, GI(TS@10-15 cc), GI(TS@20-25 cc), and TS. While these results can be interpreted on their own, the driving purpose of this study is to assess any differences between motion management strategies. Compression devices and anesthesia are so seldom used that the data may not be reliable. A general summary of metrics related to each motion management strategy can be seen at right.

Chance of Success/Failure Significant Difference for Each Analyzed Factor
* Anesthesia treatments excluded from table due to small sample size

	p-value < 0.05	0.05 < p-value < 0.20
Overall	PTV100 [S>F] GI(10-15) [S<F] GI(20-25) [S<F]	TS [S<F]
Breath Hold	CI [S>F] PTV90 [S<F]	PTV100 [S>F] SAS(VMAT) [S<F]
Free Breathing	NA	CI [S>F] SAS(VMAT) [S<F]
Phase Based Gated	NA	TS [S>F]
Compression Device	RoM [S<F] PTV100 [S>F]	TS [S>F]

Conclusion

The study shows that PTV coverage is a viable indicator for success if the tumor location during treatment delivery can reliably mimic static tumor treatments (i.e. Breath-hold or compression). There is no statistical significant correlation between PTV coverage and the success if free breathing or phase-based gating was used, indicating a potential effect due to tumor motion relative the field aperture. Additionally, this study has shown that conformity index was linked to success rate and indicated that it should approach unity. For some cases a CI value within the 0.95-0.96 range, with lower PTV100 may indicate under coverage. It is important to make the treatment decisions that are most likely to lead to successful outcomes. With SBRT treatments, respiratory motion management selection is a key part in the process to achieving a successful outcome and should be based on range of respiratory motion, patient tolerability to breath hold, and breath cycle reproducibility.

Treatment Technique Success Rates (%)
* Anesthesia treatments excluded from table due to small sample size

	VMAT	3DCRT	Overall
Breath Hold	94.59	100	95.56
Free Breathing	91.03	97.14	92.22
Phase Based Gated	91.94	88.89	90.13
Compression Device	50	96.04	95.15

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