Separating the Dosimetric Consequences of Changing Tumor Anatomy from Positional Uncertainty for Conventionally Fractionated Lung Cancer Patients

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Planning CT
CBCT, mid treatment
Introduction

• Our physicians asked “When should we re-plan a patient?”
Introduction

• Eclipse planning study involving 20 patients

• Conventional lung plans using a co-planar technique
  • 3 mm cord PRV < 50 Gy
  • max cord dose ≤ 45 Gy
  • PTV V95% ≥ 100%
  • MLD < 20 Gy

• No reduction in treatment volumes, no dose escalation
What we did

“Worst” – case scenario

Range: 4 – 515 ccs, Avg: 142 cc
Dose Volume Histogram

- PTV
- Cord
- Esophagus
- Brachial Plexus
- Heart

Some structures are unapproved or experimental.
Lung Dose

Dose Volume Histogram

- Normal lung
- Lung, but diseased lung
- Total Lung

Some structures are unapproved or rejected.
Lung Dose

Dose Volume Histogram

Relative dose [%]

Ratio of Total Structure Volume [%]

Dose [cGy]

Normal lung

Healthy lung

Some structures are unapproved or rejected
Unshifted original plan compared to original plan with 5 mm shift to patient’s right
Original Plan with 5 mm shift to patient’s right compared to Modified Plan with 5 mm shift to patient’s right

Dose Volume Histogram

PTV
Cord
Esophagus
Total Lung
Brachial Plexus
Heart

Some structures are unapproved or rejected
Key Points

• The effect of tumor change alone is minimal

• Positional shifts cause a greater effect…

and this effect is only slightly increased by tumor changes
Results: PTV V95% (%)

No shifts - Modified vs Original

Modified Shifted 2 mm vs Original

Modified Shifted 5 mm vs Original

Original Shifted 2 mm vs Original

Original Shifted 5 mm vs Original

Avg of |Diff| = 0.09 %

Avg of |Diff| = 0.44 %

Avg of |Diff| = 2.7 %

Avg of |Diff| = 0.48 %

Avg of |Diff| = 2.8 %
Results: Maximum Cord Dose (Gy)

No shifts - Modified vs Original

Modified Shifted 2 mm vs Original

Modified Shifted 5 mm vs Original

Original Shifted 2 mm vs Original

Original Shifted 5 mm vs Original

\[ \text{Avg of } |\text{Diff}| = 0.85 \text{ Gy} \]

\[ \text{Avg of } |\text{Diff}| = 1.2 \text{ Gy} \]

\[ \text{Avg of } |\text{Diff}| = 2.3 \text{ Gy} \]

\[ \text{Avg of } |\text{Diff}| = 0.68 \text{ Gy} \]

\[ \text{Avg of } |\text{Diff}| = 1.9 \text{ Gy} \]
Conclusions

• The effect of changing tumor anatomy alone is minimal

• The effect of positional uncertainties is greater

• Efforts should be focused on accurate localization and robust treatment planning

• Question: “When should we re-plan a patient?”

• Answer: “In situations not involving dose escalation, you don’t need to.”
Questions?