Introduction

- Pancreatic cancer is the 4th leading cause of cancer-related death in the US.
- Proton therapy (PT) poses a great potential alternative treatment to photon therapy due to:
  - Dose escalation
  - More organs-at-risk (OARs) sparing
- With 2D Image Guidance (IG), 5 mm uniform optimization target volume (OTV) is widely accepted.
- However, conservative 5 mm OTV compromises plan quality.
- By introducing 4D IG with real-time gated proton therapy (RGPT), margins can be reduced to allow more room for dose escalation.

The Question is: Can we reduce OTV margins from 5 mm without losing robustness and plan quality?

Methods and Results

-Dosimetric Materials
  - 5 LAPC patients previously treated with SBRT are planned for SBPT with 33 Gy(RBE) in 5 fractions.
  - Three OTV expansion schemes are compared:
    1) 5mm Uniform Expansion (OTV5m)
    2) 2mm Uniform Expansion (OTV2m)
    3) Beam Specific Water Equivalent Thickness (Non-Uniform Expansion (OTVwet))
  - \( OTV_{wet} = 2\text{mm} \text{ laterally} + \text{ setup uncertainty} + 3.5\% \text{ GTV depth beam direction} \text{ range uncertainty} \)

-Plan Quality Comparison
  - SBPT plans are compared based on:
    - Target Dose Coverage (T.D.):
      - D98% = 33 Gy(RBE)
    - OAR sparing (Duodenum, Stomach, Bowel) (O.S.):
      - V3.3 Gy(RBE) < 1cc and V20 Gy(RBE) < 20cc

-Results:
  - T.D.(OTV2m) = T.D.(OTVwet) = T.D.(OTV5m)
  - O.S.(OTV2m) > O.S.(OTVwet) > O.S.(OTV5m)

Plan Quality Comparison

\[ \text{OAR Sparing (Duodenum, Stomach, Bowel)} \]

\[ \text{Target Dose Coverage (T.D.)} \]

\[ \text{T.D.(OTV2m)} \]

\[ \text{O.S.(OTVwet)} \]

\[ \text{O.S.(OTV5m)} \]

Robustness Evaluation

- SBPT plans are perturbed with:
  - 2 mm setup error in all directions
  - 3.5% range error in beam direction

- OTVwet shows a highly robust performance compared to the other schemes.
- OTV5m shows most promising results if only OAR-sparing and target coverage are considered.
- However, delivery of SBPT is associated with setup and proton beam range uncertainties.
- OTVwet shows a highly robust performance compared to the other schemes.
- The results of our study demonstrate a considerable improvement of overall SBPT plan quality when beam specific OTVwet is used.

Conclusion

- The results of our study demonstrate a considerable improvement of overall SBPT plan quality when beam specific OTVwet is used.

References