On-treatment changes in pediatric parameningeal rhabdomyosarcoma treated with upfront proton therapy

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Background

- 2nd year medical student
- Performed with Department of Radiation Oncology at St. Jude Children’s Research Hospital
- Initial work performed in St. Jude 2021 POE program
- Follow-up worked performed throughout the fall semester
Background

• Mentors
  – Dr. Chia-ho Hua, PhD  St. Jude Radiation Oncology, Medical Physics
  – Dr. Jinsoo Uh, PhD  St. Jude Radiation Oncology, Imaging Scientist
  – Dr. Matthew Krasin, MD  St. Jude Radiation Oncology, Physician

Dr. Chia-Ho Hua, PhD  Dr. Jinsoo Uh, PhD  Dr. Matthew Krasin, MD
Project Background

- **Proton therapy** is used frequently in pediatric tumors
  - More conformal dose distribution than photons
  - Beam can be shaped to avoid critical structures (organs-at-risk or OARs)
  - However: dose profile is more sensitive to variations
- **Adaptive therapy** has been shown to benefit patients in past research
  - Adaptive therapy: adjusting treatment plan during treatment to account for observed changes
- **Questions of interest**
  - Can we describe tumor anatomic changes in our patient population?
  - Can we quantify changes to dose distribution and determine the impacts to treatment goals?
  - Does adaptive therapy benefit patients in this population?

Depth-Dose Curves
Green: photon
Red: individual proton curves
Blue: "Spread out Bragg peak"

Project Description

- 15 pediatric patients treated at St. Jude with upfront proton therapy for parameningeal rhabdomyosarcoma (PM-RMS) on RMS13 trial (NCT01871766)
- Retrospective analysis of benefits of adaptive therapy on this population (who were treated with adaptive therapy methods originally)
- Synthetic CT from MRI (using deformable image registration) allowed generation of dose distribution changes during treatment
- “Updated” dose profiles allowed for analysis of effects of variations in patient anatomy on tumor treatment parameters (dose to tumor and OARs)
Initial RT plan  24 days

Initial RT plan  36 days

Eye R (90.9%)

% of prescription dose

Days from RT simulation

Retropharyngeal LN R (91.2%)
Tonsil R (81.0%)
Larynx (63.3%)
Submental space (27.7%)
Submandibular gland R (21.9%)

% of prescription dose

Days from RT simulation
Project Evaluation

• Most recent portion of the project focused on effects of dose distribution variation on OARs
• Our theory was that some OARs would receive increased dose because of changes in beam profile within patient
• We examined the dose profile changes to major OARs in head and neck region during treatment
  – Generated sCT scans -> updated dose distributions
  – Delineation of key OARs on sequential MRI scans during treatment
  – Determination of updated dose delivered on the updated patient anatomy
Results and Conclusions

• 15 patients analyzed for dose changes to OARs
• Prior work had demonstrated 2/15 patients had significant decline in tumor coverage (V95 < 95%)
• 7/15 had increase in dose to OARs (defined as increase of > 5% initial prescribed dose to a key OAR)
• This reinforces the prior research work showing that adaptive therapy can benefit proton therapy patients by preventing tumor dose coverage failures and overdosing of OARs
Educational Aspects

• Gained knowledge on proton therapy and pediatric tumor treatment
• Learned some of the language and medical underpinnings of radiation therapy
• Learned how to use clinical radiation oncology software (Eclipse, MIM)
• Brushed up on analysis capabilities in MATLAB
Most Challenging Aspect

• Several difficult areas, a few worth mentioning
• It was tough to delineate structure outlines with confidence (had to review past images, prior structure outlines from clinicians, and anatomy resources) esp. with pathology present
• Understanding the dosimetric outputs well enough to discern “true” and “false” positive results
• Ensuring multi-step data processing (across different machines and patients) was consistent, valid, and logical
Highlight of Project

• Looking back at the images in MIM (imaging software) and seeing how much more data/analysis is there now than the beginning
• Demonstrating merit in the initial research hypothesis
• Being able to continue my research experience from the summer into the fall and now spring (and expand into different areas)
Bibliography


Questions?