St. Jude Children's Research Hospital

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

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Presented for LSP

1/11/2022

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

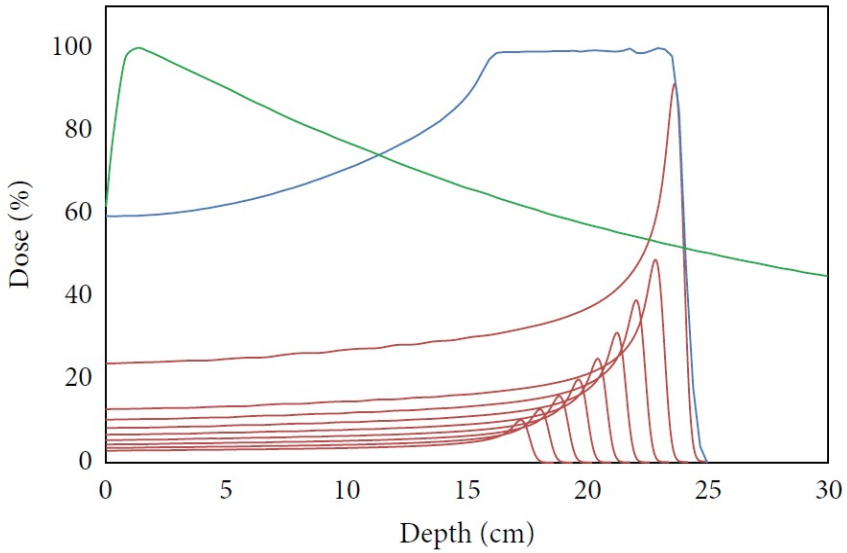
- Proton therapy is used frequently in pediatric tumors
  - More conformal dose distribution than photons
  - Beam can be shaped to avoid critical structures (organs-at-risk or OARs)
  - However: dose profile is more sensitive to variations
- Adaptive therapy has been shown to benefit patients in past 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

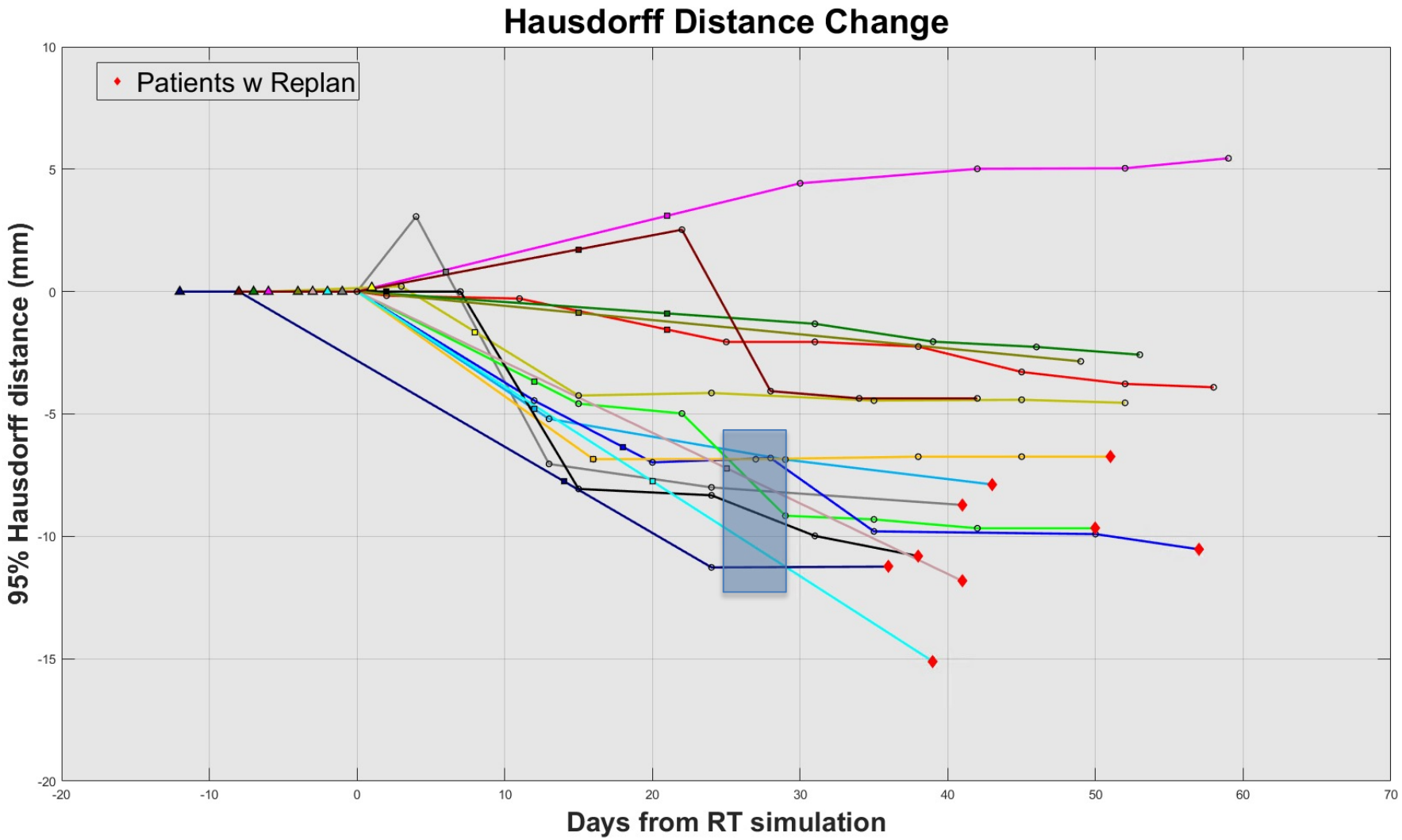
Blue: "Spread out Bragg peak"



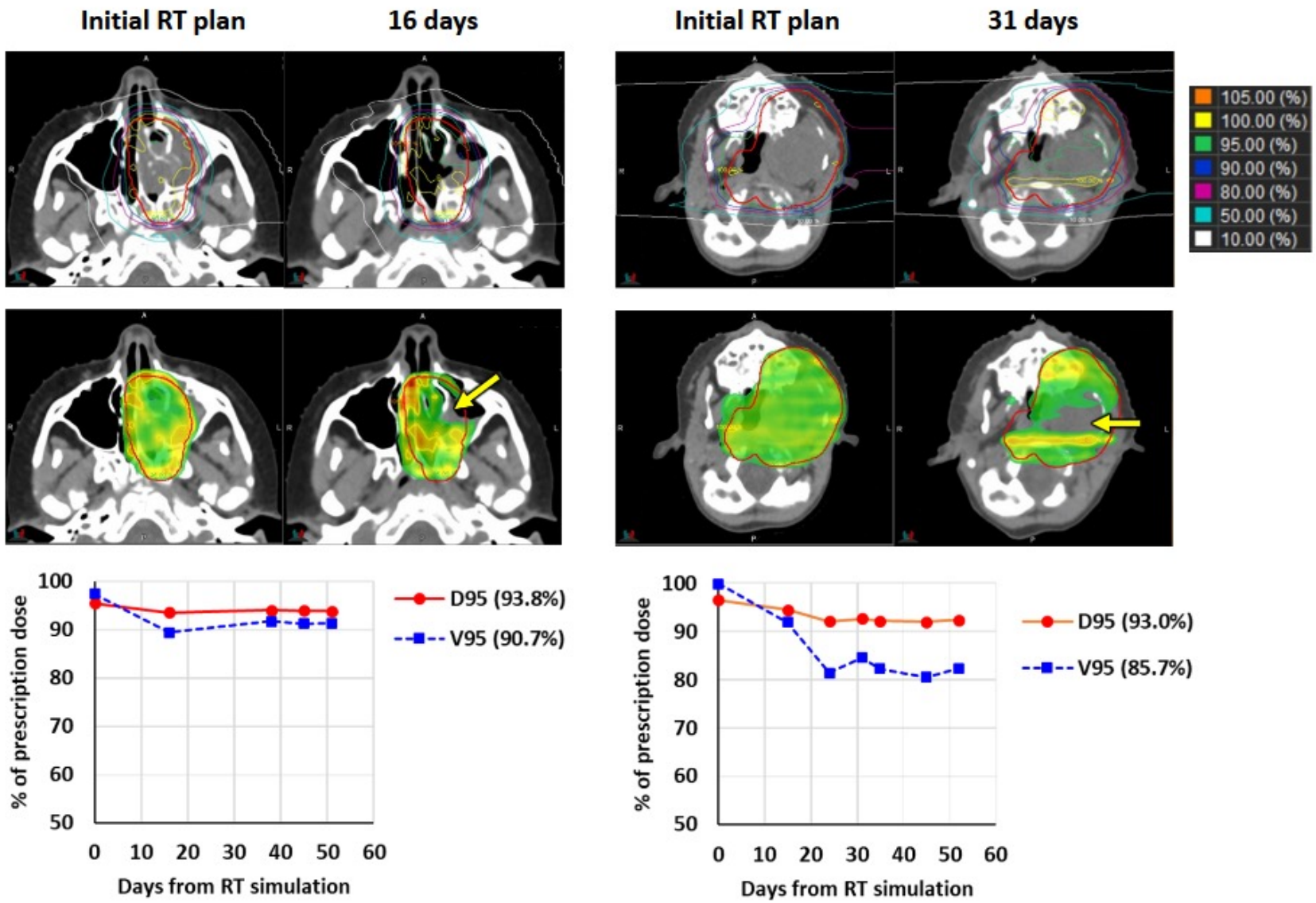
Grant and Chang. 2014, *Biomed Res Int*.

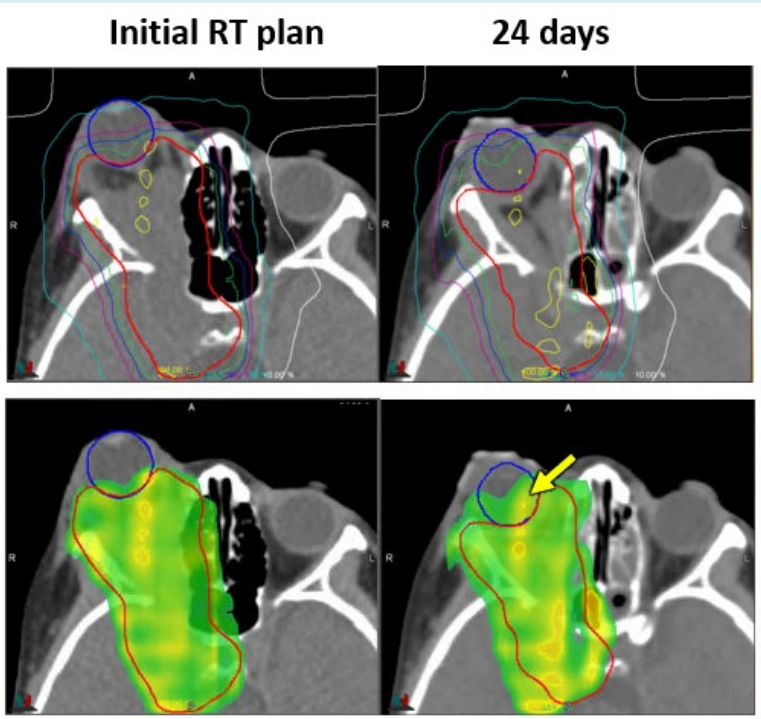
Project Description

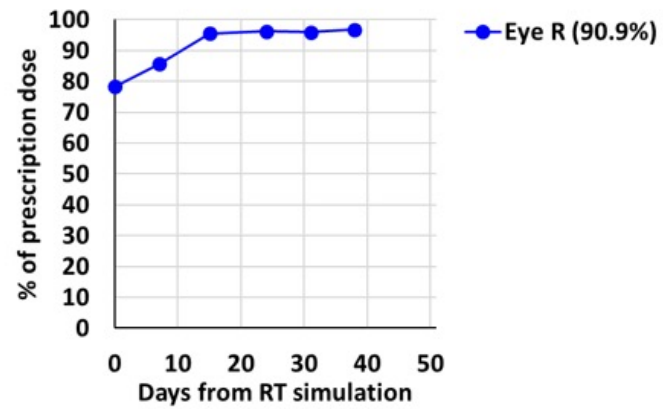
- 15 pediatric patients treated at St. Jude with upfront proton therapy for parameningeal rhabdomyosarcoma (PM-RMS) on RMS13 trial (NCT01871766)
- Retrospective analysis of benefits of adaptive therapy on this population (who were treated with adaptive therapy methods originally)
- Synthetic CT from 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)

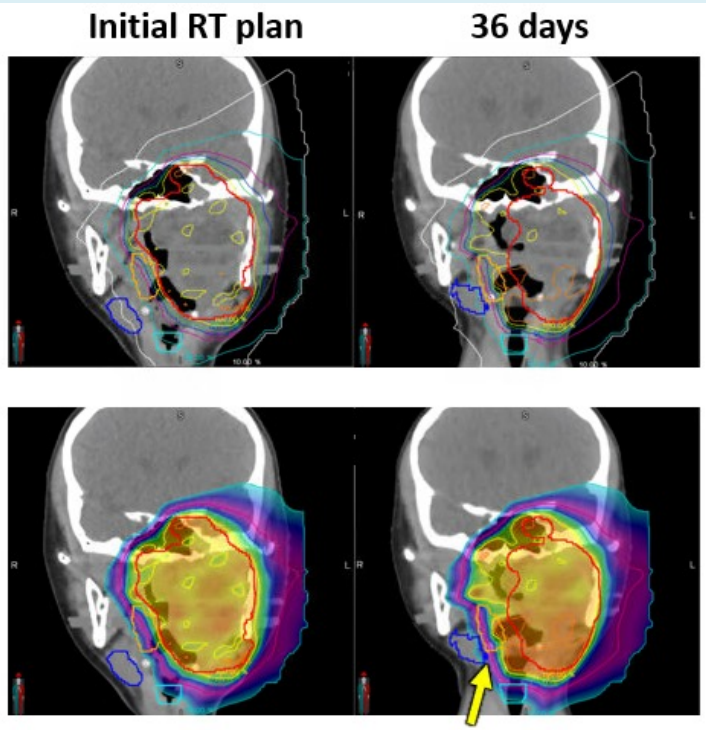


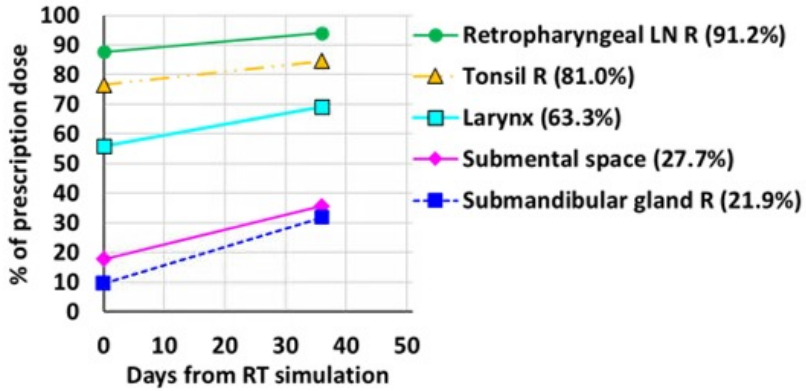
Uh et al. 2021, *ASTRO Annual Meeting*


Initial RT plan
16 days
Initial RT plan
31 days
105.00 (%)
100.00 (%)
95.00 (%)
90.00 (%)
80.00 (%)
50.00 (%)
10.00 (%)
% of prescription dose
100
90
80
70
60
50
0 10 20 30 40 50 60
Days from RT simulation
D95 (93.8%)
V95 (90.7%)
% of prescription dose
100
90
80
70
60
50
0 10 20 30 40 50 60
Days from RT simulation
D95 (93.0%)
V95 (85.7%)


Initial RT plan
24 days


% of prescription dose
Days from RT simulation
Eye R (90.9%)


Initial RT plan
36 days


% 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%)

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

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Questions?