Introduction

Proton Radiotherapy

Proton radiotherapy is a form of radiation treatment that uses high-energy protons to break DNA, leading to cell death and killing cancers.

SFUD vs MFO

- Types of planning optimization methods for Pencil Beam scanning
- Single-Field Uniform Dose, SFUD, is composed of multiple fields individually optimized at different locations to deliver a homogenous dose across a tumor (Fig. 3&4).
- Multi-Field Optimization, MFO, is used when a tumor is surrounded by healthy, vital organs and tissues that can be harmed by radiation. The beams in this plan are all optimized simultaneously, so that they can vary the intensity of radiation delivered at each voxel, working around organs at risk (Fig. 2&5).

Hybrid

In practice, treatment plans are a combination of SFUD and MFO, or a hybrid plan. As shown in Fig. 6, each beam deposits varying intensities of dosage to different voxels, the MFO component. The two beams have the same intensity distributions, so they are doing the same thing, just coming in from different positions.

SFUD-MFO spectrum, we created two Ys for a graph. The 5th, four of the five metrics, there were limits to make sure any more than a single peak per beam delivering 100% of the dose, while an MFO has multiple uneven peaks.

Important Factors

- Number of Peaks
- Distance/Slope/Midwidth
- Difference

As seen in Fig. 2, the peaks in each of the two beams are almost identical in an SFUD plan as opposed to an MFO (Fig. 2&3). This means that the greater the difference is between the peaks of the beams, the more MFO the plan is.

Methods

Research

Our research revolves around analyzing the beam distributions represented in the dDVH graphs of each treatment plan, and creating a robust procedure to classify them on a spectrum of how uniform they are, from full SFUD to full MFO. With this, we would be able to identify when it is or is not necessary to turn on the MFO setting.

Analysis

To analyze and classify the treatment plans into the SFUD-MFO spectrum, we created a procedure that goes through five weighted factors in the dDVH graphs to classify the type of plan being used (Fig. 8&9).

Important Factors

- Number of peaks
- Distance to end of beam
- Absolute difference
- Width at half-height
- Slope

Results

We analyzed 236 patients in total. The table in Fig. 11 shows each of the 5 metrics used for the final rank of each patient. The table and graphs show that as the rank of the patients increases, the graph becomes more even until they are completely single-field uniform dose.

Conclusions

The rankings presented trends about the uniformity of certain treatments as seen in Fig. 12. These trends can help dosimetrists more readily identify the most efficient treatment plan to use for future patients and the program allows them to confirm that they have the safest and most efficient plan before applying it to the patient.

References