Advantages of proton beam patching compared with IMXT in dose planning

Wanjie Proton Therapy Center
Qing Chen

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A major advantage of protons is the physical property of the Bragg peak with no exit dose, which allows lower normal tissue doses for a prescribed tumor dose.
The physical property of the Bragg peak allows the use of beam patching, a unique proton treatment technique to improve tumor dose coverage and avoid critical organs or decrease dose to critical organs.
This paper will show that use of patching beams in proton treatments can have a number of advantages over IMXT, particularly for cases where tumors surround critical organs.
This study includes 5 patients whose tumour wrap around the brain stem and are characterized by their concavity.

Chordoma
Varian TPS (Eclipse V 7.3.10 – application build; V 7.1.67.1 – Server build) was used for both proton and IMXT plans.

Newer version forthcoming (Version 8.1 in 8/2007)

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Two pairs of “patch and through fields” were used, with the patch lines drawn manually depending on tumour shape at each CT & MRI slice.
7 beams were used in each IMXT plan, equally spaced at 51 degrees from each other.
Enjoy the meeting!
Plan was normalized such that 95% isodose line covers the tumour volume. Calculation results were evaluated using DVHs.
All the cases showed similar results, that in proton patch beam plan, the average and maximum doses of the brain stem were lower than those in the IMXT plans, while tumour dose coverage was similar.
Proton patch fields allows a large selection of permissible gantry angles so as to shape the isodose surfaces conformally around the brain stem. Proton patch beams have significant advantages over IMXT.
Each proton plan with patch fields requires half a day for planning. Additionally, 3~5 days are required for plan calculation and optimization.
Each IMXT plan requires on the average 3 days for plan calculation and optimization.
For proton patch beams, patch line definition is done manually and requires significant planner efforts.
Hot spots (120% of prescription dose) appear near the patch line in the target volume.
How to avoid these hot spots in the plan?

What is the reason of the hot spots?
- Proton beam distal falloff will in general be different from lateral penumbra
- Additionally,
  - Tissue inhomogeneity
  - Compensator smearing
  - Tumour shape
  - Patient skin variations …

Improvements from new Eclipse version?
Verification ???
Water phantom, Films,……
How to work with proton???
Question on use of beam patching?

- Optimal to treat the patient with all pairs of patch and through fields in one fraction,
  - Impossible to do due to patient throughput requirements.
  - If just treat patient with 1 pair of patch beam per fraction
    - physician desired dose homogeneity?
    - Biology effect?
Results:

- Proton beam patching is better than IMXT for the case we describe before, but planning is difficult.
- Slightly higher skin surface dose compared to IMXT.
We suggest that TPS companies improve tools for designing proton patch and through fields, in order to maximally utilize the advantages of proton treatments, particularly for cases with unfavorably shaped tumor volumes.
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Thanks for your attention!