A new hybrid MR method for defining concomitant boosts in brain IMRT

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Background

The brain is a good candidate site for the application of simultaneous boosting since both inter- and intra-fractional movements are very small. Although functional imaging has the potential to target regions that would benefit most from boost doses, it is not universally available; moreover, various technical and clinical issues surrounding its implementation in radiotherapy treatment planning remain, one issue being poor resolution. Conventional MR images, such as T_1-weighted (± contrast), T_2-weighted and FLAIR, have long been used in diagnosis and treatment planning and have superior resolution to most functional techniques. We propose that these established techniques be amalgamated to derive anatomical parameter maps of tumour existence probability, denoted TEP, and escalated dose be prescribed to these volumes.

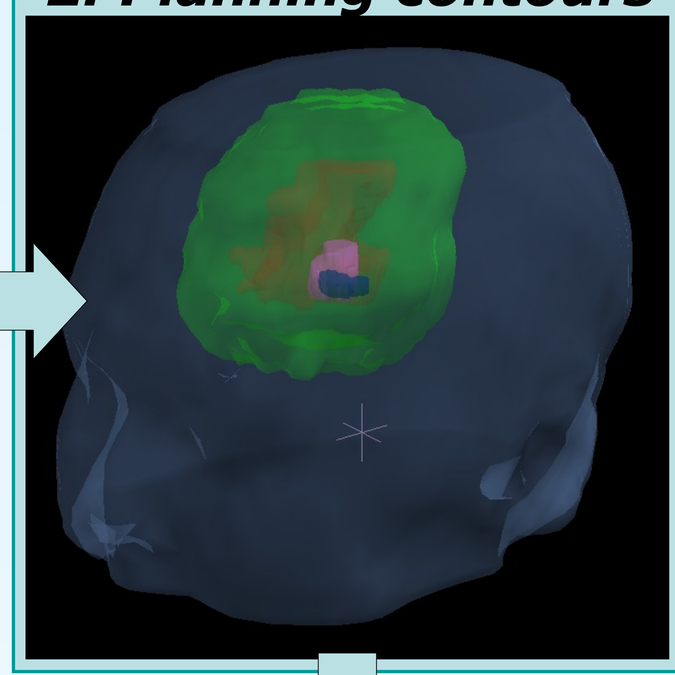
Method

In-house software has been developed that reads in multiple images generated via different MR sequences. Here, the user guides an automatic region-based contouring tool to delineate the region of abnormality on both datasets independently. The program then compares the contours slice by slice and fuses them to form a parameter map of TEP derived from set theory analysis of the different contours. Finally, the parameter map is overlaid on the anatomical images and exported in DICOM format to the TPS. Here, escalated dose is prescribed to the TEP volumes plus a planning margin, alongside a conventional dose to the standard PTV.

HYBRID MR METHOD

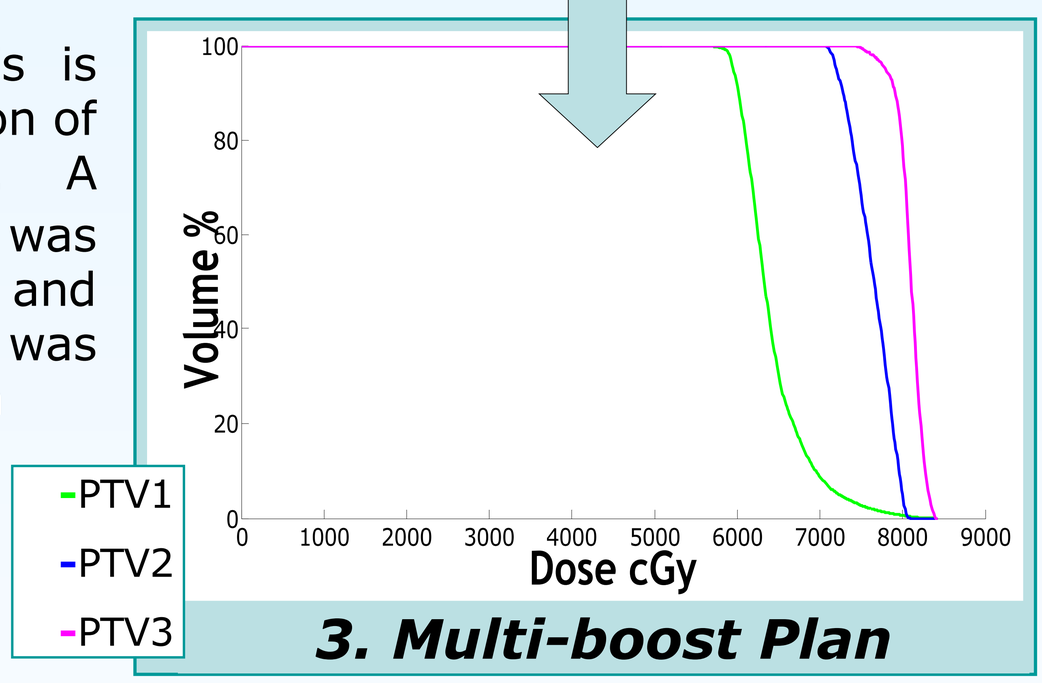
1. Image amalgamation software

2. Planning contours



Results

Data from a patient with a single brain metastasis is presented showing 3 TEP levels defined by amalgamation of T_1-weighted (post contrast) and T_2-weighted images. A treatment plan guided by the TEP parameter map was generated where escalated dose of 60 Gy to the PTV and 75 Gy and 80 Gy to the TEP derived boost volumes was prescribed. This was achieved with negligible effects on normal tissue irradiation when compared with the non-boosted plan. To date, three other (retrospective) patients have been planned successfully with this method.



3. Multi-boost Plan

Conclusion

The hybrid MR method is an effective means of defining concomitant boosts in brain IMRT and the high resolution of the approach results in smaller planning margins on the boost volumes when compared with certain functional techniques. As the uncertainties associated with functional imaging data become better understood, this too could be incorporated into the parameter map. A greater number of more meaningful TEP levels could then be derived and truly individualised "intelligent" IMRT dose sculpting realised.