Anatomical changes in mesothelioma patients: effect on proton dose distributions and benefits of early replanning

1) To evaluate the dosimetric effects of anatomy changes in patients affected by malignant pleural mesothelioma (MPM) on intensity modulated proton therapy (IMPT) plans and 2) to propose an approach to mitigate this effect.

Materials and Methods: The study was based on the planning CT and either 3 or 4 verification CT scans acquired during the course of the treatment of five patients treated with trimodality approach (surgery + chemo + radiationtherapy). CT scans were registered with automatic rigid registration on bony anatomy. Structures contours were copied on the verification CTs and manually adjusted by a radiation oncologist. Changes in the volume of air pockets within the CTV over the treatment course were quantified.

For each patient, a 2-fields IMPT plan was generated on the planning CT and then recalculated on the verification CTs. The effect of replanning early in the treatment cycle was evaluated by replanning on the first control CT (taken after about one week of treatment) and then recalculating on the remaining control CTs.

Results: The CT data showed a systematic reduction of the air volume in the CTV over the treatment course: the mean reduction between planning CT and last control CT was 80±13% (range: 63-100%). The dosimetric impact on the planned dose distributions is summarized in Table. A decrease of V98 in the CTV up to 17.2% was observed, along with an absolute +24% in V107. Dramatic discrepancies were not observed for OARs: the typical increase in mean dose for liver and ipsilateral kidney was 2Gy and 3Gy, respectively. However relative differences up to 40% were found in V40 for oesophagus. The IMRT plan provided similar results as IMPT concerning target coverage, but because of the larger OARs, it is more robust. However even after the last recalculuation IMPT is still better. When IMPT treatments were re-planned on the first verification CT and then recalculated on the remaining verification CTs, smaller differences were found (see figure), especially concerning the target coverage (on average V98 decreased only by 4.7%). For both the liver and ipsilateral kidney the mean dose increase was less than 1 Gy. A 4D-CT scan was acquired for one patient to assess intrafraction organ motion. Results showed no impact.

Conclusions: With conventional PTV-margin based planning, IMPT would be less robust to geometrical changes than IMRT, resulting in reduced gains with regard to the mean dose delivered to OARs on CT. Adaptive CTV-based treatment strategies are expected to fully exploit the benefits of IMPT, especially for patients with large geometrical changes. This study defines a reference to quantify the benefit of these proton strategies.

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Effects of anatomical changes on the dose using proton treatment planning system

Purpose/Objective: Proton therapy has the potential to deliver a superior distribution of radiation dose to the patient compared with photon therapy. On the other hand, proton treatments are more sensitive to setup variations and anatomical changes. In particular, a site where proton therapy could be highly beneficial is lung cancer. However, the anatomical changes in lung cancer provide a big challenge to deliver the planned dose. As part of the development of probabilistic planning systems, where knowledge about geometrical uncertainties is taken into account during plan optimization, we are studying the effect of observed anatomical changes in lung cancer patients on scanned beam proton treatments.

Materials and Methods: We selected three lung cancer patients with tumors close to the mediastinum that might be eligible for SBRT with protons, while they cannot be delivered with photons due to dose limiting constraints. For each patient we had the planning CT and five CBCT scans available. We used the research Pinnacle³ Intensity Modulated Proton Therapy (IMPT)/Spot Scanning treatment planning system, consisting of two beams and optimized using the same limiting constraints. In some cases this degradation couldn’t be clinically negligible degradation of target coverage and dose homogeneity is so much the dosimetric outcome in term of OAR irradiation, a not over treatment course. While these anatomical changes don’t affect the stability of dose distributions over the remaining treatment time.

Results: A systematic reduction of air pockets within CTV occurs over treatment course. While these anatomical changes don’t affect so much the dosimetric outcome in term of OAR irradiation, a not over treatment course. Y.Z. Szeto, Y.Z. Szeto, J. Gora, J. Gora, J. H. Johannes Hopfgartner, P.K. Peter Kues, B.P. Brigita Paskeviciute, D. G. Dietmar Georg

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A systematic reduction of air pockets within CTV occurs over treatment course. The results show the planned dose was evaluated using the original plan in Pinnacle³. The dose differences between the planned and delivered proton dose were evaluated on each patient of the three patients in the PTV. The results show the planned dose was evaluated using the original plan in Pinnacle³. The dose differences between the planned and delivered proton dose were evaluated on each patient of the three patients in the PTV.