Introduction

A dual-layer micro multileaf collimator [I] was designed specifically for intensity modulated radiotherapy (IMRT) and stereotactic radiotherapy (SRT). The dual-mMLC based TPS, CrossPlan, will be evaluated and verified against a reliable and accepted treatment planning system (TPS). The dose calculation in CrossPlan is based on a 3D-grid in the patient coordinate system. This grid consists of small cubic cells (3D-cells) with a dose value assigned to each one. For each beam orientation, the treated volume in the beam coordinate system is divided into 2D-layers by parallel planes (layers) perpendicular to the beam axis. The layers are divided into 2D cells. The dose value is calculated at each cell of every layer in the beam coordinate system.

To evaluate the 3D dose matrix calculated by CrossPlan, Pinnacle3 is selected as a benchmark treatment planning system for the trial comparison and dose verification as Pinnacle3 has been widely used in clinic for reasonable long period of time. Since the difference of dose engine and dose data, it is necessary to develop a toolkit for processing the conversion and transportation of the 3D dose matrices.

Materials and Methods

In order to compare radiation treatment plans between CrossPlan and Pinnacle3 TPS, the calculated dose data from both TPSs are integrated into one TPS, which is Pinnacle3. A toolkit was developed for the purpose of manipulating the 3D dose matrices generated by CrossPlan and Pinnacle3 TPS. The toolkit converted the CrossPlan 3D dose matrix and exported to the Pinnacle3 TPS. Two different trails based on the same patient setting were planned by CrossPlan and Pinnacle3. A Pinnacle3 script is written out by the tool which allows the Pinnacle3 TPS to setup the appropriate parameters and import the CrossPlan generated dose data. A plan with multi-segments was selected on cylindrical solid water phantom and the dose matrices computed by both CrossPlan and Pinnacle3 TPS were evaluated. Three beams were used in the plan with the field sizes as 2x2cm, 5x5cm, and 9x9cm. The comparison parameters include isodose comparison, dose profiles, dose difference, gamma analysis [II], and dose volume histogram. The RIT dose analysis tools, RIT113 Version 4.4 were selected to evaluate the performance of dose profiles, gamma analysis, and dose difference.

Results

The in-house toolkit was implemented to convert the 3D dose matrix calculated by CrossPlan shown as Fig 1(a) and export to Pinnacle3 as Fig 1(b). Fig 2 shows the dose calculated by CrossPlan and Pinnacle3 TPS separately in a heterogeneous phantom, in which Fig 2 a) by CrossPlan and Fig 2 b) by Pinnacle3. Fig 3 a) shows one CT scan slice of transverse view of isodose line and Fig 3 b) presents the DVH of the three phantoms. In Fig 4, two dose images were generated at the same position from the CrossPlan and Pinnacle3 as shown at Fig 4 a) and Pinnacle3 as Fig 4 b) respectively. Fig 4 c-d) shows close match among the isodose lines overlay from the CrossPlan-based dose image and Pinnacle3-based dose image. The maximum dose difference between the CrossPlan and Pinnacle3 was less than 11% at the penumbra of the field edge as shown in Fig 3(a). The gamma analysis provided the good agreement with less than 2% gamma value exceeding the pass/fail threshold (gamma = 1) as shown in Fig 4 c - d). Both dose horizontal and vertical profiles as Fig 4 c - d) offer very close match between the images generated by CrossPlan and Pinnacle3 TPS with the mean dose difference was less than 1% with the majority dose difference among +/- 3%.

Conclusions

The toolkit has been developed for processing the conversion and transportation of 3D dose matrix generated by a Pinnacle3 and CrossPlan TPS. Overall, the comparison by using various parameters provided close match between the Pinnacle3 and CrossPlan TPS. The toolkit turns out to be efficient and effective for research applications which enable the comprehensive trial comparison between Pinnacle3 and the dual-layer mMLC-based CrossPlan TPS.

References
