

In our study, we concluded that JO-IMRT plan can provide isodose distribution far superior than that of 3D plan. In the prostate case, the JO-IMRT plan can match the results of the MLC-based IMRT plan. The use of JO-IMRT will benefit clinics with limited resources for advanced technology because the implementation of JO-IMRT does not require additional hardware on the accelerators.

Introduction

Intensity modulated radiation therapy is commonly delivered by modulating the radiation beam with multi-leaf collimator or compensator. Both methods produce a highly conformal dose distribution to the target volume. An alternative method for beam modulation is by using the standard collimator jaws. In this approach, the radiation beam is modulated by varying the dimensions of the collimator jaws. Prowess, Inc. has developed a Jaw-only IMRT (JO-IMRT) planning software based upon the Direct Aperture Optimization (DAO) method.

In the aperture optimization method, the aperture shapes at each beam angle is predefined based upon the shape of the target and the organ-at-risk. During the optimization process, the aperture shapes and weights are optimized simultaneously. Because the shapes of the target and organ-at-risk are usually irregular, the multi-leaf collimator (MLC) has an inherent advantage over the collimator jaws in defining the aperture shapes. Therefore, we do not expect JO-IMRT will produce better conformal dose distribution than MLC-based IMRT. The purpose of this study is comparing the JO-IMRT plan to the 3D conformal radiation therapy (3D CRT).

Methods

To study the efficacy of the JO-IMRT in clinic, we use a commercially available planning system (Panther, Prowess, Inc., Chico, CA) to create JO-IMRT plans and compare the result to some actual cases that we treated with our clinical planning system. This is not a comparison between two planning systems, rather a comparison of JO-IMRT to 3D CRT and MLC-based IMRT. Since the JO-IMRT is developed primarily for accelerators without multi-leaf collimator, these accelerators would most likely have a single low energy photon 6MV. In the following cases, 6MV photon was used for all JO-IMRT plans.

I. Prostate Carcinoma

A patient with stage T1c prostate carcinoma received 54Gy to the PTV of the prostate and seminal vesicles in 30 fractions and a boost of 23.4Gy to the PTV of the prostate only. Two JO-IMRT plans were created with 7 beam angles and 7 to 9 apertures per beam to meet the dose requirement for each PTV. The composite plan was compared to a 3D CRT plan with 6 beam angles of 6 MV Photons and a MLC-based IMRT plan with 5 beam angles of 15 MV photons.

Results

The isodose distribution of the composite JO-IMRT plan is shown in three orthogonal views in Figure 1. The isodose distribution is very conformal to the PTV. Good dose sparing of the neighboring critical organs was obtained. The peripheral dose was high due to the low energy photon used in the plans. Figure 2 shows the aperture segments and intensity maps of the beams. The rectangular segments are representations of collimator jaw settings.

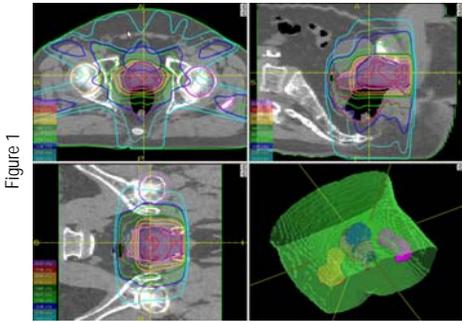


Figure 1

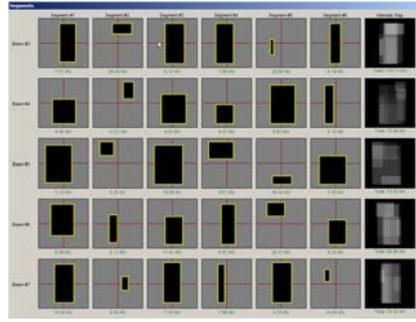


Figure 2

The dose-volume histogram (DVH) is shown in Figure 3. The solid lines represent results of the JO-IMRT plan while the broken lines represent the results of the 3D CRT plan. Both plans gave similar dose to the PTV and the bladder; however, the JO-IMRT plan would provide better rectal sparing than the 3D CRT plan. Figure 4 shows the DVH of a MLC-based IMRT plan. The JO-IMRT plan compared very well with the MLC-based IMRT plan.

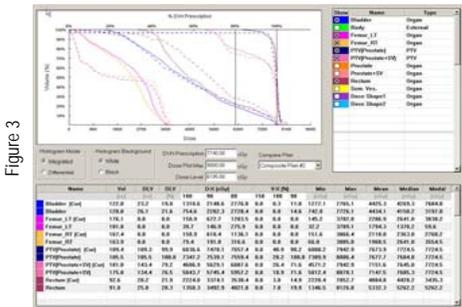


Figure 3



Figure 4

II. Maxillary Sinus

A patient with right maxillary spindle cell carcinoma received 66Gy to the surgical site. The JO-IMRT was planned with 8 beam angles and 17 apertures per beam. This plan was compared to a 3D CRT with two orthogonal beam angles with and without wedges.

Results

The isodose distribution is shown in three orthogonal views in Figure 5. The DVH is shown in Figure 6.

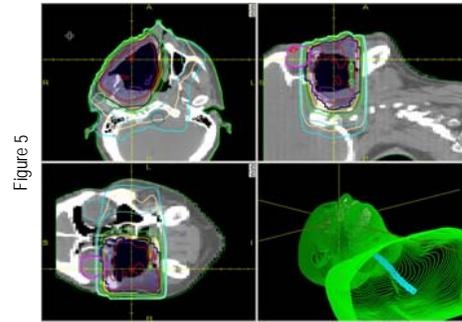


Figure 5

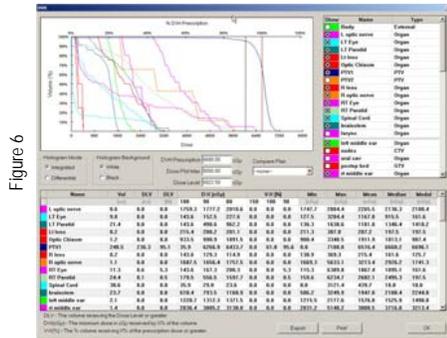


Figure 6

The isodose distribution and the DVH of the 3D CRT plan are shown in Figure 7 and Figure 8, respectively. The JO-IMRT plan was more desirable because it spared the critical organs better than the 3D plan while giving comparable dose to the PTV.

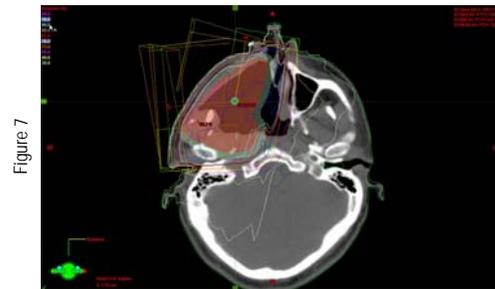


Figure 7

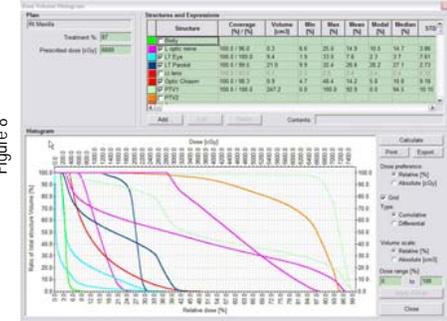


Figure 8

III. Posterior Fossa Ependymoma

A pediatric patient status post neoadjuvant chemotherapy and gross total resection of a large aggressive ependymoma involving the 4th ventricle, cerebellopontine angle, with extension along the anterior aspect of the cervical spine. The JO-IMRT was planned with 9 beam angles and 9 apertures per beam for a target dose of 54Gy.

Results

The isodose distribution is shown in three orthogonal views in Figure 9; good conformal dose distribution was obtained. The DVH is shown in Figure 10; the optic chiasm, pituitary, and the left cochlea were spared. The JO-IMRT plan provided a dose distribution that was not possible with a 3D plan.

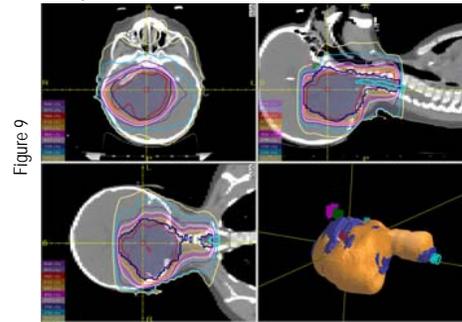


Figure 9

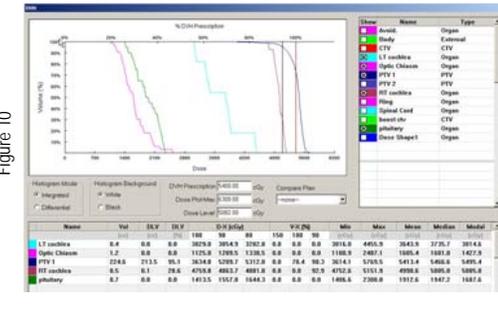


Figure 10