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Dosimetrical assessment of Jaw Tracking Technique in RapidArc for patients with lateralized targets

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Introduction

Reduction of leaked radiation in modulated Radiotherapy treatments can be optimized with Jaw Tracking Technique (JTT). With this option, collimator's jaws continually adapt to the minimal possible size for any multileaf collimator (MLC) aperture, with potential improvements in patients' healthy tissue dose and protection of Organs-at-Risk (OARs).

In a number of patients, keeping the isocenter nearer to the patient's center than the actual target can be helpful to allow full gantry rotation, avoid gantry collisions and spare couch motions for image guidance with Cone Beam CT (CBCT). However, it leads to wider apertures of the MLC. JTT could be even more effective in such conditions.

AIM

The objective of this work was to compare dosimetric parameters between jaw tracking technique (JTT) and static jaw technique (SJT) in RapidArc, in a sample of patients with lateralized targets and isocenter in patient's midline.

Method

Twenty-seven abdominal and thoracic SBRT patients were planned with JTT and SJT using Eclipse v15.1 and 6MV or 10MV photon beams of a TrueBeam STx linear accelerator (Varian - Brainlab). Comparison were done using total monitor units (MU),PTV's D95%, D2%, Paddick's CI (PCI), for PTV-PRVs, and healthy tissue's V5Gy, V10Gy, V20Gy and Dmean.

Among the SBRT plans, 19 patients presented pancreatic cancer, 5 lung and 3 in other localizations. 25 plans with SJT were replanned with JTT and 2 cases with JTT were replanned with SJT. In 18 plans 6MV was employed and 10MV in the remaining.

The mean apertures of the linac jaws was related to the healthy tissue dose. For SJT plans, the average jaws-only field area for the treatments was determined, weighting each arc jaws-only field area, by the amount of monitor units delivered by the arc with respect to the total monitor units. For the JTT plans, the average jaws-only field area of every arc field was first determined from the Eclipse report of control points and then weighted by the amount of monitor units, to obtain a weighted average jaws field area. Then the ratio of these jaws field areas for each patient was plotted with the variations of the registered dosimetrical parameters in order to search for a possible relationship using Spearman's and Pearson's coefficients.

Results

Figure 1 shows an example of the beam of view (BEV) for an arc with SJT (up) and JTT (below) for one patient, where the Jaws-only field area is less with JTT. Figure 2 shows the corresponding dose distributions. A greater area with low dose values can be observed in the SJT, as well as a dose ring-shaped artifact. D95% for the PTV-PRVs with JTT increased only a 0.7% as average, a not statistically significative difference according to the Student's t-test (p = 0.12). The average difference in D2% was a little more significative with JTT, 1.4% and p = 0.0005. The dose conformation showed also a small improvement with the application of JTT, with a PCI average increase of 4% with JTT, with an overall p value of 0.06 by Student's t-test.

The V5Gy and V10Gy of healthy tissue with JTT plans decreased by an average of 10%, with statistical deviations of 7 and 8%. These decrements were statistically significative, with p values of 3e-8 and 2.4e-6, respectively, by Student's t-tests. V5Gy decreased in 26 patients, with a maximum decrease of 29%. The only increase case was of 0.44%. V10Gy decreased in 25 patients, with a maximum of 24%. The increase cases were of 4% and 14%. The V20Gy of healthy tissue decreased only by 1.4% average with standard deviation of 7% and p value of 0.036. It decreased in 17 cases (maximum decrease, 15%) and increased in 10 cases (maximum increase, 21%) The mean dose values in the healthy tissue decreased an average of 11±7% and p = 5.1e-8. The decrement was seen in 26 plans with a maximum difference of 27%. For 1 plan there was no difference. These results for the healthy tissue are summarized in Graphic I.

The MU decreased by an average and standard deviation of 4±13% with JTT (p-value of 0.08 for the Student's t-test)

A correlation was found between the ratios of the jaws-only, monitor units-weighted, average fields areas, with healthy tissue mean dose reduction, as well as with V5Gy, when JTT plans were compared to standard ones. Graphics II and III presents this relationship. Spearman's and Pearson's correlation coefficients in the first case were 0.751 (p =1e-5) and 0.804 and, in the second case, 0.754 (p=1e-5) and 0.801 in the second.

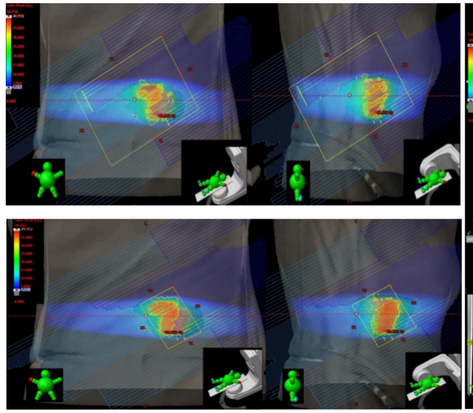


Figure 1 (up) SJT plan (below) JTT Plan

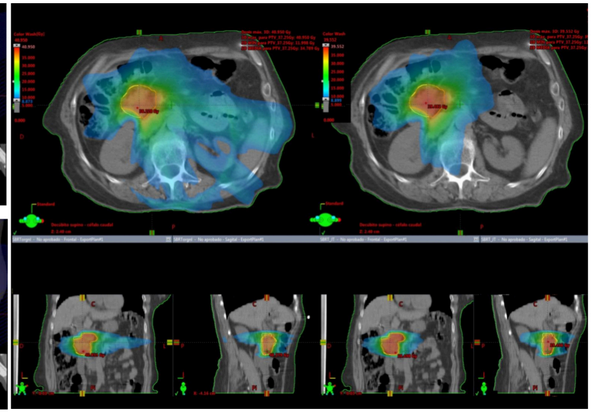
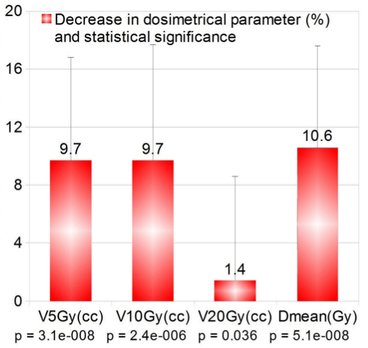
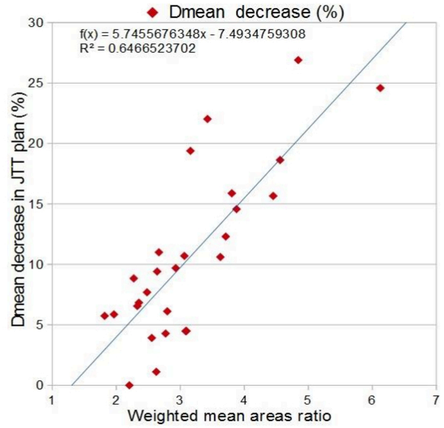


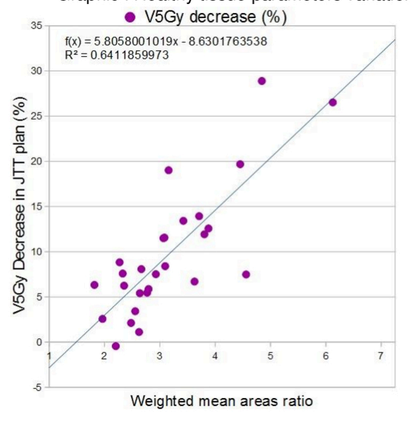
Figure 2 Resulting dose distributions (left) SJT Plan (right) JTT Plan



Graphic I Healthy tissue parameters variation



Graphic II Relation between Dmean decrease and weighted mean areas ratio



Graphic III Relation between V5Gy decrease and weighted mean areas ratio

Conclusions

An improvement in the healthy tissue doses was obtained in the majority of the plans, according to the changes in the values of the specified dosimetrical parameters. The amount of monitor units did not show a tendency to increase. A correlation was found between the reduction of the jaws defined field area and the decrease of the healthy tissue mean dose and low dose volumes, as reflected in V5Gy. These results suggests that the JTT can be advantageously applied in VMAT plans, especially in the cases where the plan's isocenter is located at the center of the patient and the target is off-center.

References

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