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Treatment planning for the lung cancer

Sukhdeep Gill

Department of Radiation Oncology, University of Toledo, Toledo, Ohio, USA.

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Letter to editor

Volumetric modulated arc therapy (VMAT) and intensity modulated radiation therapy (IMRT) are commonly used treatment techniques for cancer treatment, and both the VMAT and IMRT techniques use the photon beam (mega-voltage X-rays) to deliver radiation dose to the tumor. The capability of modulating radiation beam has increased the ability of delivering more conformal dose distributions to tumor volume while minimizing dose to the normal tissues. The VMAT planning generally involves one or multiple arcs with gantry rotating around the patient, whereas the IMRT planning involves multiple static beams.

Current literature on radiation therapy for the lung cancer shows the publication of good number of dosimetric studies, which are typically focused on the treatment planning techniques [1-7] and dose calculation algorithms.[8-16] The treatment planning studies comparing the dosimetric quality between the IMRT and VMAT, however, do not provide the definitive conclusion, especially for the normal lung tissue. For example, Verbakel *et al.* [1] performed the dosimetric study on 14 lung cancer cases and compared the IMRT and VMAT plans. It was reported that the V5 of the normal lung tissue was higher in the VMAT plans than in the IMRT plans. Ong *et al.* [2] and Jiang *et al.* [3] also reported higher V5 of the lung in the VMAT plans. The V5 of the lung from these studies [1-3] show that the IMRT could be better at sparing the lung than the VMAT. However, the VMAT plans could produce lower values for the lung if dosimetric evaluation is done using different parameters. In the study by Jiang *et al.* [3], normal lung was also evaluated for the mean dose, V20, and V30, and the results showed lower values in the VMAT plans than in the IMRT plans.[3] This leads to the question- which dosimetric parameter for the normal lung tissue is more important when plan evaluation is done?

Corresponding author: Sukhdeep Gill; Department of Radiation Oncology, University of Toledo, Toledo, Ohio, USA.

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In addition to the sparing of normal tissues, the target coverage and dose homogeneity within the target volume are also equally important in radiation therapy. Jiang *et al.* [3] found that the VMAT could produce better target coverage when compared to the IMRT. However, Rao *et al.* [4], who performed study on 8 lung cases, found comparable target coverage in the VMAT and IMRT plans. Dose to the target volume was found to be similar in the VMAT and IMRT plans.[3-5]

The variation in the reported results from various studies on lung cancer [1-7] can be attributed to different factors such as plan optimization technique, experience of the treatment planner, treatment volume margins, dose prescription, location of the tumor, and dose calculation algorithms. The treatment plan optimization interface within the treatment planning system can let the user to assign weightings and objectives for the target and normal tissues. The final dosimetric results in the treatment plan may depend on the selection of weightings and objectives for the structures. Additionally, the plan optimization can be repeated with same set of optimization parameters or different ones if the dosimetric results have deviation from the compliance criteria.

Dose calculation algorithm incorporated in the treatment planning system can also affect the dosimetric results of the treatment plans, especially for the lung cancer, which includes the low-density medium. When radiation beam traverses the human body before it reaches the tumor, tissues of different electron density are encountered in the beam path. Presence of heterogeneity along the beam path may change the dose contribution to the tumor when compared to the homogeneous geometry. Such situation requires the dose calculation algorithm to consider the tissue heterogeneity correction when dose computations are performed on the cancer treatment plans.

Recent literature shows that the Monte Carlo based dose calculation algorithm is more appropriate for dose computations in the lung plans.[8-10] Several investigators compared the analytical anisotropic algorithm (AAA) with the most recent algorithm called Acuros XB for the lung plans [9-16], and vali-

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dation studies on Acuros XB show its superiority over the AAA, especially in inhomogeneous media.[8-9, 11, 17-18] The beam modeling within the Acuros XB algorithm considered to be based on the Monte Carlo approach.[18]

The literature comparing the AAA and Acuros XB in the lung plans showed that the Acuros XB could produce higher values for the V20 [11, 12] and V5.[10-12] If the Acuros XB is considered to be more accurate than the AAA, does the AAA underestimate the lung dose? It was also reported that the higher number of monitor units (MUs) will be required for the Acuros XB in order to achieve the target coverage similar to that of the AAA.[9] The decreased target coverage using Acuros XB for the same number of MUs as in the AAA plans may not be clinically acceptable. If the treatment planning systems have an option to normalize the plan (e.g., target volume receiving certain percentage of the prescription dose), the Acuros XB plans can be normalized to achieve the desired target coverage, but such method may also increase the MUs, and this will increase the normal tissue dose and hot spot. Hence, treatment plans computed with different dose calculation algorithms are likely to provide different dosimetric results. Treatment plans calculated with different beam energy may also produce difference dosimetric results.[19, 20]

Although there are uncertainties in the dosimetric results between the IMRT and VMAT plans, the common agreement among different published studies [1-7] is the decreased delivery time and a smaller number of MUs using the VMAT than using the IMRT. Clinical trials comparing the IMRT and VMAT may be more helpful in establishing superiority of one technique over another. Multi-institutional study using the same dataset, beam parameters, and dose calculation algorithms/treatment planning system would help in reducing the uncertainties in the dosimetric results of the lung treatment plans. Studies based on the radiobiological models in the treatment planning could also be beneficial for more accurate prediction of tumor control and normal tissue complication.[21]

Conflict of interest

The authors declare that they have no conflicts of interest. The authors alone are responsible for the content and writing of the paper.

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