Advancement in lung cancer treatment using external beam radiation therapy

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Scientific Note

Radiation therapy is considered to be one of the major options to treat the lung cancer. Lung cancer is the leading cancer killer in the world, and the primary goal of radiation therapy is to kill the cancer cells while sparing the normal tissues. Among different techniques available for the radiation therapy, 3D conformal radiation therapy (3D-CRT), intensity modulated radiation therapy (IMRT) and volumetric intensity-modulated arc therapy (VMAT) are commonly used to treat the lung cancer.\(^1,2\) The 3D-CRT is capable of producing conformal dose distribution, but this technique does not modulate the intensity of the beams, whereas, both the IMRT and VMAT have the capability of modulating radiation beam. Hence, there is a growing interest in using IMRT and VMAT for the lung cancer treatment. One of the fundamental differences between the IMRT and VMAT is that VMAT can deliver the dose while the machine is rotating around the patient, but in IMRT, dose is delivered in the form of static beams.\(^1,2\)

Researchers report that VMAT is an attractive option for treatment due to lower treatment time associated with it. Also, monitor units (MUs) can be lower in the VMAT plan than in the IMRT plan. Both the IMRT and VMAT can be used in the form of stereotactic body radiotherapy (SBRT), which allows the delivery of high dose in three to five fractions. The main objective of this letter is to address advanced radiotherapy techniques such as IMRT and VMAT for the lung cancer treatment.

Various planning studies have used VMAT for lung cancer treatment. For example, Zhang \textit{et al.}\(^3\) studied 15 SBRT cases and showed that relative volume of lung receiving 5 Gy and 20 Gy (V5 and V20, respectively) of lung were lower in the VMAT plans when compared to the ones in the 3D CRT plans. Similar result was reported by Bree \textit{et al.}\(^4\) who studied 20 lung cancer patients and found that IMRT and VMAT techniques resulted better dose conformity in comparison to 3D CRT. In addition, both IMRT and VMAT allowed higher dose to the target volume, and this could increase the tumor control. But, authors did not notice significant changes in homogeneity of target dose among different techniques.

Some other studies have shown less difference between the IMRT and VMAT plans. Rao \textit{et al.}\(^5\) studied 8 case and reported similar results in terms of target coverage and normal tissue sparing. Holt \textit{et al.}\(^6\) studied for 27 cases and showed that the VMAT was similar to IMRT. In a different study, however, Jiang \textit{et al.}\(^7\) demonstrated better target coverage using VMAT than using IMRT. Additionally, Jiang \textit{et al.}\(^7\) reported less treatment time and lower dose to the lung using VMAT than using IMRT. Scorsetti, \textit{et al.}\(^8\) showed that both IMRT and VMAT plans had similar dose homogeneity and coverage, with VMAT plans being slightly better at sparing normal tissues. Interestingly, Verbakel, \textit{et al.}\(^7\) reported higher lung dose using VMAT plans than using IMRT. Ong \textit{et al.}\(^9\) showed that, VMAT plans could produce lower V45 of the chest wall and higher V5 of the healthy lung when compare to the 3D-CRT. In the study published by Merrow \textit{et al.}\(^10\) for 14 cases, SBRT VMAT was compared to the 3D CRT. This particular study showed superior dosimetric results in VMAT plans than in 3D CRT plans. Rana \textit{et al.}\(^11\) performed a study on using SBRT VMAT technique to quantify the dose differences between Acuros XB algorithm and Anisotropic Analytical Algorithm (AAA). It was shown that doses calculated by AAA and Acuros XB will differ in lung cases, and this could produce different dosimetric results for the target volume and lung.\(^12\)


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Advancement in radiotherapy treatment continues to demand sophisticated planning systems and delivery techniques in an effort to treat the cancer. Since one patient case can be different from that of another, it may not possible to get the same results although same treatment technique is used. This could ultimately contradict results of one study with another. Verbakel et al.\textsuperscript{9} reported similar V20 of lung using IMRT and VMAT, but Rao et al.\textsuperscript{5} concluded that IMRT is better at sparing lung with lower V20. For a general reader, this may be confusing, and one must be aware of the fact that different factors could influence the dosimetric results. Currently, there are various treatment planning systems in the market. Hence, treatment plan generated in one planning system will differ from the one generated in another planning system. This is because each planning system has its own dose calculation and optimization engine, and the modeling parameters will be different among various dose calculation engines. This fact has already been discussed by several authors\textsuperscript{12-18}, who have shown that accuracy of dose calculation algorithms is very important when low-density tissues are involved in the beam path. If the dose calculation engine is not accurate enough to compute the dose, the patient will receive either overdose or underdose; thus resulting unfavorable patient treatment outcome. In addition to the difference in planning system and dose calculation engine, it is also important to note that the experience of the treatment planner may influence the results. Also, it has been reported that results are dependent on the number of beams/arches used in the given treatment plan. VMAT is capable of generating excellent dose distributions compared to the IMRT and 3DCRT. Further studies on the use of VMAT would validate this technique as the major treatment options for lung cancer treatment using photons.

References


