Evaluation for Direct Aperture Optimization(DAO) in Intensity Modulation Radiotherapy(IMRT) treatment planning

[1]Hong-seok Jang · [2]Dong-min Jeon · [2]So-hyun Park · [1]Young-nam Kang · [1]Byeong-oak Choi · [1]Yeon-shil Kim · [2]Tae-suk Suh · [1]Sei-chul Yoon
[1]Dept. of Radiation Oncology, Seoul St. Mary's Hospital , The Catholic University of Korea, Seoul, Korea
[2]Dept. of Biomedical Engineering, The Catholic University of Korea, Seoul, Korea
E-mail: hsjang11@catholic.ac.kr

Keyword : IMRT, Direct Aperture Optimization(DAO), Treatment planning, MatriXX

Introduction

Intensity Modulated Radiation Therapy (IMRT) is a means of delivering radiation therapy where the intensity of the beam is varied within the treatment field. One of the main problems of IMRT, which becomes even more apparent as the complexity of the IMRT plan increases, is the amazing increase in the number of Monitor Units (MU) required to deliver a fractionated treatment. The difficulty with this increase in MU is its association with increased treatment times and a greater leakage of radiation from the MLCs increasing the total body dose and the risk of secondary cancers in patients. Many approaches have been taken to reduce the complexity. .In this study, we used a direct aperture optimization (DAO) IMRT plan Direct aperture optimization IMRT is an IMRT method in which the aperture shapes and aperture weights are optimized simultaneously, and the MLC constraints and the number of segments are directly included in the optimization process. In DAO-IMRT planning, the planner specifies the planning objectives on the basis of the dose volume criteria for the target and critical structures as well as the number of beam segments to be delivered. The optimization only considers aperture shapes that satisfy the conditions set by the MLC. As a result, high-quality DAO-IMRT treatment plans can be generated using fewer segments (apertures) per beam. We investigated the dosimetric and technical differences in using DAO-IMRT. We also compared DAO-IMRT plans with standard beamlet-IMRT plans on phantom in terms of dosimetry, number of segments, and monitor units.

Materials and methods

We used the Pinnacle planning system (Philips Radiation Oncology Systems, Milpitas, CA) for beamlet-IMRT planning and the Prowess Panther planning system (Prowess, Chico, CA)for DAO-IMRT planning. All planning methods used beam parameters of Siemens Artiste , with 160 MLCs and virtual wedge. Cubic phantom(30×30×30 cm, IBA,USA) adpated MatriXX(IBA, USA) were scanned with 1.5 mm CT slice thickness. Arbitrary ROIs were contoured on each phantom scaned image. Each plan was calculated with 7 beams and 20 Gy prescription dose. Estimation of plan

optimization were used MatriXX dose scan system. It was compared with each plan.

Each plan was assessed based on the calculation time, the composite objective value used in the optimization, the number of segments, monitor units (MUs), and treatment time.

Result and discussion

The results showed DAO-IMRT to be superior to the traditional optimization method. When planning data of DAO-IMRT are respectively compared with beamlet-IMRT planning, results were observed in the dosimetric quality of DAO_IMRT plans, which also required 36% less time to calculate, maximum 42% fewer MUs, and 49% fewer segments than the beamlet-IMRT1 optimization method. These reductions translated directly into a 29% decrease in treatment times. Estimation of dose optimization using MatriXX, it was not observed definite difference for each plan. In beamlet-IMRT, the difficulty with this increase in MU is its association with increased treatment times and a greater leakage of radiation from the MLCs increasing the total body dose and the risk of secondary cancers in patients. In this study, DAO-IMRT shows the decreased treatment times and a lower leakage of radiation. And, it was caused decreasing scatter dose and the risk of secondary cancers.

Conclusion

In conclusion, we found that DAO-IMRT can achieve equal or better plans than standard beamlet-IMRT in dose optimization, secondary scattering dose and treatment time. The DAO-IMRT planning is proficient, and the plans can be delivered efficiently because small numbers of segments and monitor units are used.

Reference

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