Medical Dosimetry ■■ (2017) ■■–■■

Medical Dosimetry

journal homepage: www.meddos.org

Dosimetry Contribution:

A study of the dosimetric characteristics between different fixed-field IMRT and VMAT in early-stage primary mediastinal B-cell lymphoma

Li-Ming Xu, M.D.,[*,†] Ming-Lei Kang, Ph.D.,[†,‡] Bo Jiang, Ph.D.,[*] Qing-Feng Liu, M.D.,[†] and Ye-Xiong Li, M.D.[†]

[*]*Department of Radiation Oncology, Key Laboratory of Cancer Prevention and Therapy, Tianjin Medical University Cancer Institute and Hospital, National Clinical Research Center for Cancer, Tianjin Clinical Research Center for Cancer, Tianjin 300060, China;* [†]*Department of Radiation Oncology, Cancer Hospital, Chinese Academy of Medical Sciences and Peking Union Medical College, Beijing, 10021, China; and* [‡]*Department of Radiation Oncology, MedStar Georgetown University Hospital, Washington, DC 20007, USA*

ARTICLE INFO

Article history:
Received 3 May 2017
Received in revised form 24 August 2017
Accepted 25 August 2017

Keywords:
Primary mediastinal large B-cell lymphoma
Intensity-modulated radiotherapy
Volumetric-modulated arc therapy
Radiotherapy plan
Dosimetric comparison

ABSTRACT

This analysis was designed to compare dosimetric parameters among different fixed-field intensity-modulated radiation therapy (IMRT) solutions and volumetric-modulated arc therapy (VMAT) to identify which can achieve the lowest risk of organs at risk (OARs) and treatment delivery efficiently. A total of 16 patients (8 male and 8 female) with early-stage primary mediastinal large B-cell lymphoma (PMBCL) were enrolled with planned gross tumor volume (PGTV) 45 Gy and planning target volume (PTV) 40 Gy. Four different plans were generated: 5-, 7, 9-field IMRT, and VMAT. The dose distributions for PGTV and PTV OARs (lungs, left ventricle, heart, thyroid gland, and breasts) were compared. The monitor units (MUs) and treatment delivery time were also evaluated. Mean conformity index (CI) and homogeneity index (HI) for PGTV in 5F-, 7F-, 9F-IMRT, and VMAT were 1.01 and 1.10, 1.01 and 1.10, 1.01 and 1.10, and 1.01 and 1.11 ($p = 0.963$ and 0.843), whereas these 2 indices for PTV were 1.04 and 1.22, 1.03 and 1.19, 1.03 and 1.17, and 1.08 and 1.14 ($p = 0.964$ and 0.969), respectively. D_{mean} (Gy), V4 (%), D50 (Gy), and D80 (Gy) to the left and right breasts increased by 0.7 Gy and 0.1 Gy, 6.8% and 7.7%, 0.9 Gy and 1.7 Gy, and 1.0 Gy and 1.5 Gy in VMAT, respectively. The 9-beam IMRT plan had the highest MUs (25,762.4 MUs) and the longest treatment delivery time (10.7 minutes); whereas, the VMAT had the lowest MUs (13,345.0) and the shortest treatment delivery time (5.9 minutes). Seven- and 9-field IMRT and VMAT provide improved tumor coverage compared with 5F-IMRT, whereas VMAT shows higher treatment delivery efficiency than IMRT technique. Seven- and 9-field IMRT slightly reduce the low dose radiation exposure of breasts compared with VMAT technique. The 7- and

L.-M. Xu and M.-L. Kang contributed equally to this work.

Reprint requests to Li-Ming Xu, M.D., Department of Radiation Oncology, Tianjin Medical University Cancer Institute & Hospital, Key Laboratory of Cancer Prevention and Therapy, National Clinical Research Center for Cancer, Tianjin Clinical Research Center for Cancer, Tianjin, 300060, China.
E-mail: tianjin1231@163.com

Reprint requests to Ye-Xiong Li, M.D., Department of Radiation Oncology, Cancer Hospital and Institute, Chinese Academy of Medical Sciences and Peking Union Medical College, Beijing 100021, China.
E-mail: yexiong12@163.com

http://dx.doi.org/10.1016/j.meddos.2017.08.010

9-field IMRT and VMAT techniques both can be safely and efficiently delivered to patients with PMBCL.

Introduction

Primary mediastinal large B-cell lymphoma (PMBCL) is an uncommon disease, and less than 5% of non-Hodgkin lymphoma and 6%-12% of all diffuse large B-cell lymphoma are PMBCL diseases.[1-4] Patients with PMBCL typically present with early-stage disease and involvement of the mediastinum. This entity predominantly occurs with bulky disease and invasion of adjacent organs or structures.[2,4-6] The majority of patients with PMBCL received consolidation radiotherapy following chemotherapy in previous studies.[6-9] Advanced radiotherapy techniques such as intensity-modulated radiation therapy (IMRT) have been proven superior to three-dimensional conformal radiotherapy (3D-CRT) in terms of tumor coverage, increased local tumor control probability, and dose reduction to certain organs at risk (OARs), which are particularly important in the treatment of mediastinal disease.[10-15] Our previous study[16] has confirmed that IMRT after chemotherapy resulted in an excellent overall survival and local control in patients with early-stage PMBCL. Generally, the planning target volume (PTV) is extremely large and has a symmetric geometric distribution around the middle line of the patient (see Fig. 1); therefore, one clockwise plus another counterclockwise arc fields can be a good choice for planning. We assume the beam configuration with 9, 7, or 5 fields can potentially achieve similar plan quality to volumetric-modulated arc therapy (VMAT). The study of the target coverage, organ sparing, and delivery efficiency between arc therapy and fixed-beam IMRT could be a helpful reference for clinics to choose the optimal solutions based on the availability of the techniques. We herein report data obtained from a cohort of patients with PMBCL delivered

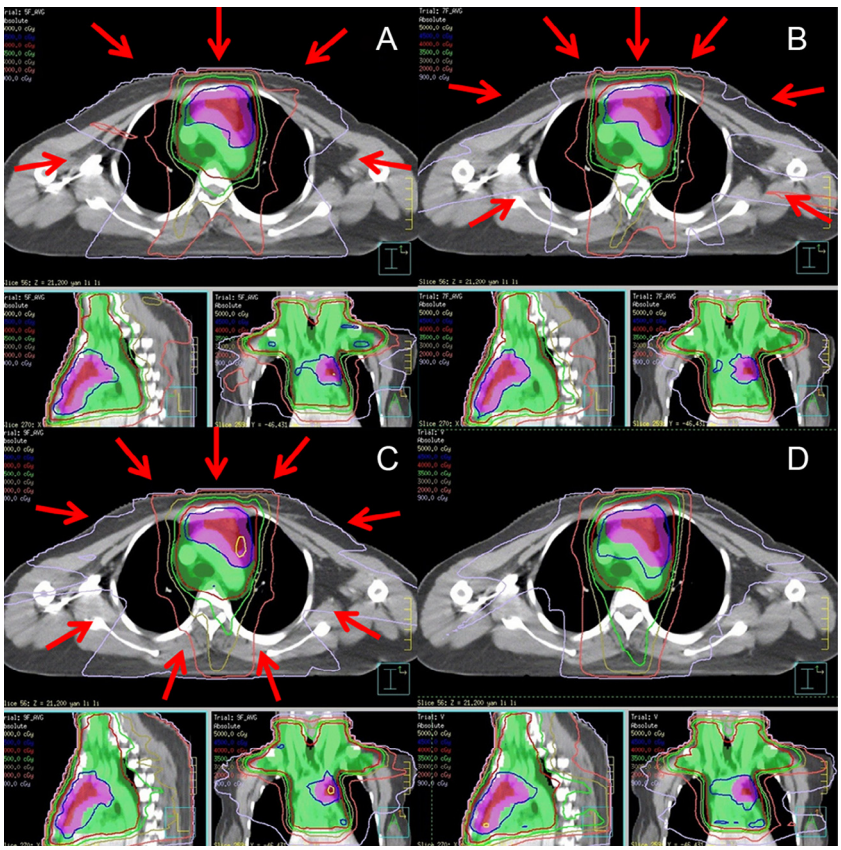

Fig. 1. Thirty-year-old female patient with stage I PMBCL received 6 cycles of R-CHOP followed by total doses of PTV 40 Gy/2 Gy/20f and PTVboost (residual disease) 45 Gy/2.25 Gy/20f. The isodose lines of plans for 5-beam IMRT (A), 7-beam IMRT (B), 9-beam IMRT (C), and VMAT (D) are shown on the axial, coronal, and sagittal planes, respectively. The arrows indicate the gantry angle for the IMRT techniques. The GTV of residual lymph nodes is in red and the planning target volume (PTV) is in green for PTV1 and pink for PTV2. (Color version of figure is available online.)