INTENSITY-MODULATED RADIOTHERAPY VERSUS 3-D TANGENTIAL THERAPY IN THE TREATMENT OF LEFT BREAST CANCER: A COMPARATIVE PLANNING STUDY

Pang-Yu Chen¹, Wen-Pin Shih¹, Ji-An Liang¹,², Shih-Neng Yang¹,², An-Cheng Shiau¹,², Shang-Wen Chen¹,², Fang-Jun Lin¹,²

¹ Department of Radiation Therapy and Oncology, China Medical University Hospital
² School of Medicine, China Medical University

Purpose: Adjuvant radiotherapy is a part of the routine care of patients with early breast cancer. However, a subset of patients with left breast cancer has been shown to be at significant risk of cardiac mortality after longer relapse-free survival. This planning study was designed to assess the efficacy of target coverage and cardiac sparing by three intensity-modulated radiotherapy (IMRT) techniques compared to three-dimensional tangential radiotherapy.

Materials and Methods: Treatment planning study was performed retrospectively on 10 selected left-sided breast cancer patients previously treated by three-dimensional tangential radiotherapy with the prescribed dose of 50 Gy in 25 fractions. All patients underwent CT scan following their breast conserving surgery. For each patient, plans were generated and compared using dose volume histograms for planning target volume (PTV) and organs at risk (OAR). Treatment planning was performed using a commercial IMRT system (Eclipse Version 7.1), and the beam fluency was delivered using a step and shoot window leaf sequence and 6-MV beams. Four different radiation techniques were analyzed: (1) 3-dimensional tangential plan (3D), (2) 2-field tangential IMRT plan (2T), (3) 2-field optimized IMRT plan (2O), and (4) 4-field IMRT plan (4I). Doses to the PTV and each OAR were compared using a paired Student's t-test.

Results: PTV homogeneity was similar for the four techniques. For all patients, the average part of the PTV receiving a dose between 95 and 107% of the prescribed dose was 96.1%, 97.4%, 96.0% and 97.6% for the 3D, 2T, 2O and 4I plans, respectively. The mean proportion of the heart receiving more than 95 / 80% of the prescribed dose was 3.4/7.4% for 3D, 2.5/5.8% for 2T, 1.7/4.5% for 2O and 1.2/2.9% for 4I techniques, while the mean proportion of lung receiving more than 20 Gy was 19.6%, 17.5%, 23.9% and 19.3% for the four plans, respectively. When compared to 3D plans, the 4I plans significantly reduced the high dose irradiation volume of heart; however, the irradiated doses to the contralateral breast were increased. The use of IMRT techniques did not increase either V20 Gy of lung or the mean left lung doses.

Conclusion: Left breast cancer patients undergoing adjuvant irradiation in which the heart receiving higher dose should be considered for alternation to IMRT plan. Better cardiac sparing effect is achievable with the use of 4-field IMRT technique without com-
promising target coverage.

Key words: Breast cancer, Intensity-modulated radiotherapy, Cardiac mortality, Cardiac dose

INTRODUCTION

Adjuvant radiotherapy is an important part of the routine care of patients with early breast cancer receiving breast conservative surgery. In combination with partial mastectomy, local control can be achieved and equivalent to mastectomy [5]. However, a subset of patients with left breast cancer has been shown to be at significant risk of cardiac mortality if these patients have longer relapse-free survival [4, 6, 9, 10, 16]. The Early Breast Cancer Trialists’ Collaborative Group showed that an increased risk of cardiac mortality of 0.8-5.6% for certain groups of patients [6]. From their data, it appears that patients with the lowest risk of dying from breast cancer are at the highest risk of cardiac mortality.

In modern radiation therapy, the therapeutic ratio should be optimized with minimal late toxicity. Therefore, it is important to identify those patients at high risk of cardiac toxicity and develop new techniques to reduce late cardiac sequelae. With a predictive model based on retrospective analysis of cardiac mortality data for patients with or without adjuvant radiotherapy, Gagliada et al. found that individual patients might have an absolute risk of cardiac mortality as high as 9% depending on the cardiac volume irradiated [7,8]. Since an excess risk of mortality from ischemic heart disease was correlated with cardiac dose volume [7, 8, 9, 12], it is our current clinical policy to reduce any high-dose cardiac irradiation whilst maintaining adequate target coverage.

Three-dimensional tangential treatment planning is not always difficult to avoid high cardiac dose. Intensity-modulated radiotherapy (IMRT) techniques have been developed to reduce dose variations and spare the organs at risk (OAR) despite of the implementation of IMRT techniques will require additional resources compared to conventional radiotherapy. Therefore, it is useful to select patients for whom IMRT is needed. There were several studies investigating the efficacy of IMRT for left-sided breast cancer [3, 12, 15], however, it is essential to establish an in-house analysis due to the diversity of beam configuration, planning strategies, and various parameters evaluated. This planning study was designed to assess the efficacy of target coverage and cardiac sparing effect by three IMRT techniques compared to three-dimensional tangential radiotherapy.

MATERIALS AND METHODS

Patient selection

Treatment planning study was performed retrospectively on 10 selected left-sided breast cancer patients previously treated by three-dimensional tangential radiotherapy. All patients underwent CT scan following their breast conserving surgery. CT-slices of the thorax were acquired in every 5 mm interval, and all patients were immobilized with supine position and left arm above the head. The CT scan included the complete left and right lung, both breast and the heart. For each patient, plans were generated and compared using dose volume histograms (DVH) for target volume and OAR.

Target delineation

The breast clinical target volume (CTV) included all visible breast parenchyma or glan-