

Research Article

A Retrospective Analysis of Lung Volume and Cardiac Dose in Left-Sided Whole Breast Radiotherapy

Diana Lee, MRT(T), BSc^a, Robert Dinniwell, MD, MSc, MScCH, FRCPC^{ab} and Grace Lee, MRT(T), CMD, MHSc^{a*}

^a Radiation Medicine Program, Department of Radiation Oncology, Princess Margaret Cancer Centre, Toronto, Ontario, Canada

^b Department of Radiation Oncology, University of Toronto, Toronto, Ontario, Canada

ABSTRACT

Objective: The purpose of this study was to assess the variability of lung volume and characterize its relationship with heart dose in women with left-sided breast cancer receiving whole breast radiotherapy.

Materials and methods: Free-breathing (FB) computed tomography scans of female left-sided breast cancer patients were retrospectively reviewed. Dose and volume parameters for the lung, heart, and left anterior descending coronary artery were collected from the FB treatment plans of 47 patients treated in FB (PT_{FB}) and 41 patients who exceeded institutional heart dose limits (≥ 10 cc of heart receiving V50%) and required the breath-hold technique using the active breathing coordinator (ABC) device (PT_{ABC}). A two-tailed Student's *t*-test and Pearson's correlation test were performed for statistical analysis.

Results: Volume of the heart and left anterior descending artery were similar between the groups ($P = .102$ and $P = .548$, respectively). Total left lung volume in FB state was significantly smaller for the PT_{ABC} group (996.9 cc; standard deviation, 253.1) when compared with the PT_{FB} group (1,207.8 cc standard deviation, 32; $P < .001$). Mean and maximum heart dose, heart V50%, V30 Gy, and V10 Gy decreased with increasing left lung volume for all patients ($P < .001$). There was an inverse relationship between left lung volume and mean heart dose ($R = -0.586$, $P < .001$).

Conclusions: Patients requiring ABC have smaller left lung volumes during FB state. Future study to assess lung volume in conjunction with other anatomic parameters in the development of an ABC screening tool is warranted.

RÉSUMÉ

Objectif : Cette étude avait pour but d'évaluer la variabilité du volume pulmonaire et de caractériser sa relation avec la dose cardiaque

Keywords: Breast cancer; radiotherapy; heart dose; breath-hold; cardiac sparing; active breathing control

chez les femmes ayant un cancer du sein gauche et recevant une radiothérapie de l'ensemble du sein.

Matériel et méthodologie : des examens tomodensitométriques en ventilation spontanée (FB) de patientes atteintes d'un cancer du sein gauche ont fait l'objet d'un examen rétrospectif. Les paramètres de dose et de volume pour le poumon, le cœur et l'artère coronaire antérieure descendante gauche ont été colligés à partir des plans de traitement VS de 47 patientes traitées en ventilation spontanée (PT_{FB}) et de 41 patientes ayant dépassé les limites institutionnelles pour la dose au cœur (>10 cc du cœur recevant V50 %) et ayant besoin de la technique de retenue respiratoire (PT_{ABC}) à l'aide de l'appareil de contrôle actif de la respiration (ABC). Un test *t* bilatéral et un test de corrélation de Pearson ont été effectués pour l'analyse statistique.

Résultats : Le volume du cœur et de l'artère coronaire antérieure gauche était similaire dans les deux groupes ($p = 0,102$ et $p = 0,548$, respectivement). Le volume total du poumon gauche en ventilation spontanée et significativement plus faible pour le groupe PT_{ABC} (996,9 cc ÉT: 253,1) comparativement au groupe PT_{FB} (1 207,8 cc ÉT: 32) ($p < 0,001$). La dose cardiaque moyenne et maximale, le V50% cardiaque, V30 Gy et V10 Gy diminuaient avec l'augmentation du volume du poumon gauche chez tous les patients ($p < 0,001$). On a constaté une relation inverse entre le volume du poumon gauche et la dose cardiaque moyenne ($r = -0,586$, $p < 0,001$).

Conclusion : Les patients ayant besoin d'un contrôle actif de la respiration (ABC) présentent un volume du poumon gauche plus faible durant la phase de ventilation spontanée. Des études plus poussées visant à évaluer le volume pulmonaire en conjonction avec d'autres paramètres anatomique dans le développement d'un outil de dépistage ABC sont nécessaires.

* Corresponding author: Grace Lee, MRT(T), CMD, MHSc, Radiation Medicine Program, Princess Margaret Cancer Centre, 610 University Avenue, Toronto, Ontario M5G2M9, Canada.

E-mail address: grace.lee@rmp.uhn.on.ca (G. Lee).

Introduction

For left-sided breast cancer patients receiving adjuvant whole breast radiotherapy (WBRT), dose received by the heart can lead to a significantly increased risk of future cardiac morbidity and mortality [1, 2]. Addition of cardiotoxic agents (eg, anthracycline chemotherapy, trastuzumab) to the treatment regimen for many of these patients further underscores the importance of minimizing cardiac dose [3]. Moderate deep inspiration breath-hold (DIBH) technique using the active breathing coordinator (ABC) device (Elekta AB) can be used in left-sided WBRT to inflate the lung. Expansion of the absolute lung volume increases the separation between cardiac structures and the target volume, thereby reducing heart dose [4–6].

The focus of many recently published studies on the use of ABC in left-sided WBRT has been on clinical feasibility, reproducibility, and dose reductions to organs-at-risk [7, 8]. However, few studies have identified the characteristics of these patients or those who would benefit most from the use of ABC technique [9]. Although beneficial, ABC may not confer the same degree of cardiac dose reduction for all left-sided breast cancer patients [10]. The use of ABC technique necessitates an increase in departmental workload with a greater use of health, human, and technical resources as well as an increase in appointment time [4, 6, 7]. After the initial treatment plan is generated, the patient's cardiac dose is evaluated. If the cardiac dose exceeds institutional limits, the patient must return for an ABC training session and a second computed tomography (CT) simulation scan with the ABC device. A second treatment plan must subsequently be generated and evaluated. Treatment time is extended with the addition of the ABC technique, and a new ABC snorkel is used for each fraction, further increasing cost to the institution. Identifying patients who require ABC upfront would eliminate the need for an additional CT simulation scan and generation of a treatment plan, thereby reducing unnecessary dose to the patient and waiting time before commencing treatment.

The objective of this study is to examine the variability of lung volume and characterize its relationship with heart dose in women undergoing left-sided breast radiotherapy.

Materials and Methods

Patient Population

This study was approved by the Research Ethics Board. Women with left-sided breast cancer previously treated with adjuvant WBRT were included in this study. All patients underwent CT simulation in free-breathing (FB) state. They were immobilized in the supine position on a carbon fiber breast board (MEDTEC), with the ipsilateral arm abducted $>90^\circ$ and contralateral arm by their side. The FB CT data sets were anonymized and imported into the Pinnacle

Treatment Planning System (Philips Medical Systems). The heart and left anterior descending coronary artery (LAD) were contoured based on the cardiac atlas described by Feng et al [11]. The heart contour included the pericardium beginning from immediately inferior to the left pulmonary artery and ended distally to the region where the heart approached the diaphragm. Lung contours were generated using the treatment planning software's autocontouring tools. Parallel-opposed tangential treatment plans were generated on the FB CT scans.

At our institution, patients with ≥ 10 cc of their absolute heart volume receiving $\geq 50\%$ of the prescription dose (V50%) were resimulated, replanned, and treated using the ABC device for heart sparing. The ABC device was used to maintain moderate DIBH, with threshold set at 75%–80% of their maximal inspiration capacity.

We identified 50 patients who were treated in the FB state (PT_{FB}) and 50 patients whose heart dose exceeded the cardiac dose limitation and were subsequently treated with ABC (PT_{ABC}). All dose and volume characteristics were collected on the FB scan. The following dose and volume characteristics were collected: left lung (total volume, minimum dose, maximum dose, mean dose, volume receiving 20 Gy [V20 Gy], 10 Gy [V10 Gy], and 5 Gy [V5Gy]), heart (total volume, minimum dose, maximum dose, mean dose, volume receiving 50% of prescribed dose [V50%], volume receiving 30 Gy [V30 Gy], and 10 Gy [V10 Gy]) and LAD (total volume, minimum dose, maximum dose, and mean dose).

Statistical Analysis

The correlation between left lung volume and dose to the heart (mean heart dose, max heart dose, V50%, V30 Gy, and heart V10 Gy) and dose to the LAD (mean LAD dose and max LAD dose) was tested using Pearson's correlation test. A two-tailed Student's *t*-test was used to determine statistical differences between the two cohorts. *P* values less than 0.05 were considered statistically significant. The data were analyzed using Microsoft Excel's Data Analysis ToolPak (version 14.0.7015.1000) software.

Results

At our institution, patients undergoing WBRT are either prescribed a dose of 42.4 Gy in 16 fractions ($n = 91$) or 50 Gy in 25 fractions ($n = 9$). To ensure a homogenous population for dose and statistical analysis, the nine patients prescribed the higher dose of 50 Gy were removed from the study (three from the PT_{FB} group and six from the PT_{ABC} group), along with three patients who were identified as statistical outliers based on their heart V50% (heart V50% values at least 1.5 times outside the interquartile range). We reported on 47 patients treated in FB state and 41 patients eventually treated with active breathing control technique.

Download English Version:

<https://daneshyari.com/en/article/5579205>

Download Persian Version:

<https://daneshyari.com/article/5579205>

[Daneshyari.com](https://daneshyari.com)