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Original Article

Effects of Preparatory Coaching and Home Practice for Deep Inspiration Breath Hold on Cardiac Dose for Left Breast Radiation Therapy☆

A. Kim *, A.M. Kalet *, N. Cao *, D.S. Hippe †, L.C. Fang *, L. Young *, J. Meyer *, E.V. Lang ‡, N.A. Mayr *

* Department of Radiation Oncology, University of Washington School of Medicine, Seattle, WA, USA
† Department of Radiology, University of Washington School of Medicine, Seattle, WA, USA
‡ Hypnalgesics, LLC, Brookline, MA, USA

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Abstract

Aims: Deep inspiration breath hold (DIBH) reduces cardiac radiation exposure by creating cardiac–chest wall separation in breast cancer radiotherapy. DIBH requires sustaining chest wall expansion for up to 40 s and involves complex co-ordination of thoraco-abdominal muscles, which may not be intuitive to patients. We investigated the effect of in-advance preparatory DIBH coaching and home practice on cardiac doses.

Materials and methods: Successive patients from 1 February 2015 to 31 December 2016 with left-sided breast cancer who underwent tangential field radiotherapy utilising the DIBH technique were included. The study cohort consisted of patients treated by a physician who routinely provided DIBH coaching and home practice instructions at least 5 days before simulation. The control group included non-coached patients under another physician's care. Minimum, maximum and mean cardiac doses and V5, V10 and V30 from DIBH and free breathing simulation computed tomography scans were obtained from the planning system. DIBH and free breathing cardiac doses and volume exposures were compared between the coached and non-coached groups using the two-sample *t*-test, Fisher's exact test and the Mann–Whitney *U*-test.

Results: Twenty-seven coached and 42 non-coached patients were identified. The DIBH maximum cardiac dose was lower in coached patients at 13.1 Gy compared with 19.4 Gy without coaching ($P = 0.004$). The percentage cardiac volume exposure in DIBH was lower in coached patients; the DIBH V10 was 0.5% without coaching and 0.1% with coaching ($P = 0.005$). There was also a trend towards lower DIBH V5 in the coached group compared with the non-coached group (1.2% versus 1.9%, $P = 0.071$). No significant differences in patient cardiopulmonary comorbidity factors that might influence cardiac doses were found between the groups.

Conclusions: Our results suggest that cardiac dose sparing can potentially be further improved with a 5 day regimen of preparatory DIBH coaching and in-advance home practice before simulation. These hypothesis-generating findings should be confirmed in a larger study.

Key words: Breast cancer; Coaching; Deep inspiration breath hold (DIBH); Heart dose; Radiation therapy; Training effect

Introduction

In women with left-sided breast cancer undergoing radiotherapy, radiation exposure to the heart is a well-known risk factor for the development of coronary artery disease and cardiac mortality [1–4]. Epidemiological studies have shown cardiac doses as low as 2 Gy to be correlated with the long-term risk of ischaemic cardiac disease [5]. Increases in the mean cardiac dose and the dose to cardiac substructures have been associated with an increased risk of developing major coronary events [6,7].

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Author for correspondence: N.A. Mayr, Department of Radiation Oncology, University of Washington School of Medicine, 1959 NE Pacific St, Box 356043, Seattle, WA 98195, USA.

E-mail address: ninamayr@uw.edu (N.A. Mayr).

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Therefore, a reduction in the dose received by the heart to levels as low as achievable is of great importance in left breast radiotherapy.

Various techniques of deep inspiration breath hold (DIBH) have been developed to address this need in breast radiotherapy. In tangential field set-ups commonly used in conventional breast radiotherapy, the cardiac volume in the treatment portal is close to and sometimes encompassed by the posterior plane of the tangential field pair. With deep inspiration, the chest wall expands along with the inferior displacement of the diaphragm. Thereby the heart is displaced medially, posteriorly and inferiorly, away from the tangential fields [8]. DIBH techniques have now become widely adopted for radiotherapy in left-sided breast cancer based on multiple studies showing a significant cardiac dose reduction compared with radiation in free breathing [9–14].

Accomplishing an effective separation between the heart and the chest wall via DIBH requires the complex co-ordination of thoraco-abdominal muscles while holding the breath for 20–40 s per session, a task that is generally not intuitive to patients. The success in achieving optimal chest wall expansion during DIBH and cardiac sparing has been variable among patients [9,10,13,15–18]. The methods of patient instruction and coaching for DIBH also vary in clinical practice, and instruction usually occurs just before the computed tomography (CT) simulation procedure [9,16,18–21]. The role of longer-term preparatory coaching for the DIBH procedure with ample time to self-practice before the simulation day has not been explored. Preparatory DIBH coaching and daily home practice before simulation has the potential to gradually improve patients' skills in co-ordinating thoraco-abdominal muscle function, further deepen their breath hold and thereby further reduce the cardiac dose during DIBH.

In the present study we explored the use of systematic, physician-guided DIBH coaching and home practice several days before simulation as a means to improve chest wall expansion and further reduce cardiac dose in DIBH. Specifically, we compared the cardiac doses and exposed cardiac volumes on the CT simulation planning scans among cohorts of coached and non-coached patients receiving radiation therapy for left-sided breast cancer.

Materials and Methods

Patients

The study was approved by the institutional review board and included consecutive patients from 1 February 2015 to 31 December 2016 who underwent tangential field radiotherapy utilising the DIBH technique for the treatment of left breast cancer at the Seattle Cancer Care Alliance radiation oncology clinic. The study cohort consisted of patients treated by a physician who routinely provided DIBH coaching and home practice instructions to patients at least 5 days before simulation (coached group), whereas the control cohort included non-coached patients under another physician's care (non-coached group). A total of 72 patients were identfied. All were female. Three patients were excluded for reasons of incomplete treatment (one), non-breast cancer histology (lymphoma; one) and a potential cross-over between the two physicians (an initial consultation by one physician and simulation and planning by another; one). After the exclusion, 27 of the remaining 69 patients were in the coached group and 42 were in the non-coached group.

Coaching

The training and practice regimen aimed to perform coaching by the physician at least 5 days before the CT simulation, as a part of a standard pre-radiotherapy visit.

The rationale for the coaching and the duration of the home practice was as follows. Stress-induced changes in breathing pattern are well documented [22,23]. We hypothesised that targeted instruction and training in the comfort of the patient's own familiar environment can reduce anxiety and stress, and improve focus and co-ordination, thereby improving DIBH performance. We based our approach and training time on evidence that respiratory training times as short as 2 weeks can increase the maximal inspiratory pressure and that a cognitive training component probably plays a role [24,25]. Our approach was also driven by the necessities of the limited time window between patient referral and CT simulation (5–14 days). We felt that the short available time frame justified our compromise of a short training duration to prevent delays in treatment start.

The coaching session was carried out at the end of the pre-radiotherapy visit and lasted about 10–15 minutes. Each patient was instructed to perform DIBH on the examination table in the supine position, with their arms above their head and their head rotated towards the right to replicate the treatment position at CT simulation. The coaching physician provided guidance for maximally expanding the upper chest wall, while maintaining a steady breath hold for at least 10 s. The patient's DIBH performance was observed by the physician and feedback was given. The DIBH practice was repeated until the patient felt comfortable reproducing her maximal DIBH and there was no visible chest wall motion observed during DIBH. The patient was then instructed to practice three sets of 10 deep breath holds each at least three times a day, with the training goal to achieve at least about 40 s of steady and consistent breath hold by the time of the simulation appointment. The physician verified at the time of simulation that the patient had practiced at home. The control group of patients, who were managed by another physician, received instructions for DIBH by the clinic staff per routine protocol on the day of the CT simulation just before simulation and imaging.

Computed Tomography (CT) Simulation

The patient was positioned supine with both arms above her head and her head neutral or tilted to the right, with shoulders, elbows and back resting on a breast board with