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Letter to the Editor

A Rapid Transition to Voluntary Breath Hold From Device-Assisted Moderate Deep Inspiration Breath Hold for Patients Receiving Breast Radiation Therapy During the Coronavirus 2019 Pandemic

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To the Editor:

Preventing infection of radiation oncology patients during the coronavirus 2019 (COVID-19) pandemic is a priority in the radiation oncology community. The highly infectious nature and severity of COVID-19 requires a critical review of practices in our radiation medicine program. The worldwide radiation oncology community has described site-specific recommendations for supporting radiation oncology patients in the setting of a global pandemic. This consensus document recommends for breast cancer radiation therapy "avoiding use of active breathing control for radiotherapy due to the risk of aerosol contamination and minimization of devices requiring decontamination."[1]

The radiation medicine program at our facility treats approximately 1300 patients per year on 4 Elekta Agility (Elekta, Sweden) linear accelerators. Breast radiation therapy makes up more than 30% of our cases. The Active Breathing Coordinator (ABC) Response v3.0 system (Elekta) facilitates moderate deep inspiration breath hold (mDIBH) for cardiac sparing breast radiation therapy. The ABC system has been used at our institution for the majority of left breast radiation therapy treatments since 2013 to reduce the radiation dose to heart. The system is fully integrated with the linear accelerator and permits gated radiation therapy delivery. Patients breathe through a snorkel into the ABC system and the system controls the volume of air in the lungs and the duration of the breath hold. Based on the recommendation to avoid use of active breathing control for breast radiation therapy in the recent publication entitled

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"COVID-19: Global Radiation Oncology's Targeted Response for Pandemic Preparedness,"[1] the medical physics and radiation therapy teams were tasked with transitioning patients receiving breast radiation therapy from mDIBH using the ABC system to a visually monitored voluntary breath hold (vBH) technique within a very short time frame.

Methods and Materials

According to our target implementation timeline of 1.5 weeks, 3 groups of patients with breast cancer were identified that would be affected by this change:

1. Patients simulated with mDIBH and currently on treatment using the ABC device. This group is subdivided into 2 subgroups:
   a. Patients completing treatment before the go-live date
   b. Patients transitioning to vBH treatment technique
2. Patients computed tomography (CT) simulated with ABC but not started on treatment
3. Patients scheduled for CT simulation with ABC

Patient numbers are summarized in Table 1. The implementation team's first priority was to transition treatment to vBH and the second priority was to modify the CT simulation process to vBH. In anticipation of the growing effect of COVID-19 on the health care system, the oncology program was required to reduce the number of patient visits to the cancer center and the decision was made to not resimulate or replan these cases. The transition from mDIBH ABC treatment to a vBH treatment without resimulating the first group of patients is described. The second group of patients will be simulated and treated using a vBH technique.

Table 1 Patient groups using ABC and corresponding effect on radiation therapy treatment

Patient group	No. of patients	Action
1(a) On treatment with ABC mDIBH, with less than 5 fx remaining	8	Continue ABC mDIBH treatment
1(b) On treatment with ABC mDIBH, with more than 5 fx remaining	13	Transition treatment to vBH
2 Scanned and planned using ABC mDIBH	11	Start treatment with vBH

Abbreviations: ABC = Active Breathing Coordinator; fx = fractions; mDIBH = moderate deep inspiration breath hold; vBH = voluntary breath hold.

Process—Treatment Delivery

In our implementation in place of the ABC system controlling the volume of air held, vBH is based on monitoring skin marks using the closed-circuit television (CCTV) system present on all linear accelerators, as described elsewhere.[2,3] Aside from the difference in breath hold techniques and the requirement to manually gate the linear accelerator, the radiation therapy delivery process remained largely unchanged. Skin marks were placed on the patient's left side in a location that was visible using the CCTV system. Skin marks consisted of 3 parallel lines separated by 5 mm. Patients were coached into vBH while the marks on the skin were monitored relative to the coronal laser. When the skin marks align with the coronal laser, the beam is turned on. Skin marks are shown in Figure 1 for a patient while free breathing (Fig 1a) and while in breath hold (Fig 1b). A countdown timer was used to monitor the breath hold duration.

In addition to monitoring skin marks relative to the coronal laser, megavoltage (MV) electronic portal daily imaging was performed. Also, during delivery of beams, MV cine images were acquired to monitor internal anatomy and to assess reproducibility of patient anatomy during an individual breath hold and from breath hold to breath hold. A practical aspect of this implementation is that for some of our treatment plans the lateral gantry angle blocked the coronal laser at the axial level of midbreast. For these cases an additional set of skin marks was made more inferiorly to permit monitoring of patient position during vBH.

Process maps describing the vBH treatment techniques were developed, tested, and revised for the following breast treatment: tangents, mono-isocentric 4 field, bilateral, and conformal boost. Figure 2 illustrates the timeline for the implementation of vBH for breast radiation therapy from the decision to transition to the go-live date.

Process—CT Simulation

During this brief period of transition from ABC to vBH, a number of scheduled ABC CT simulations were delayed until a vBH simulation protocol was developed and implemented, as the advantage of offering a cardiac sparing treatment technique was believed to outweigh the effect of a short delay in starting radiation therapy for this patient group.

The CT simulation team of radiation therapists was tasked to transition the ABC simulation process to a vBH technique. New CT scanning protocols were developed and reviewed by the committee that oversees the external beam program protocols and processes at our center. Patients able to hold their breath for a minimum of 18 s were considered eligible for vBH treatment. This minimum breath hold requirement is consistent with the

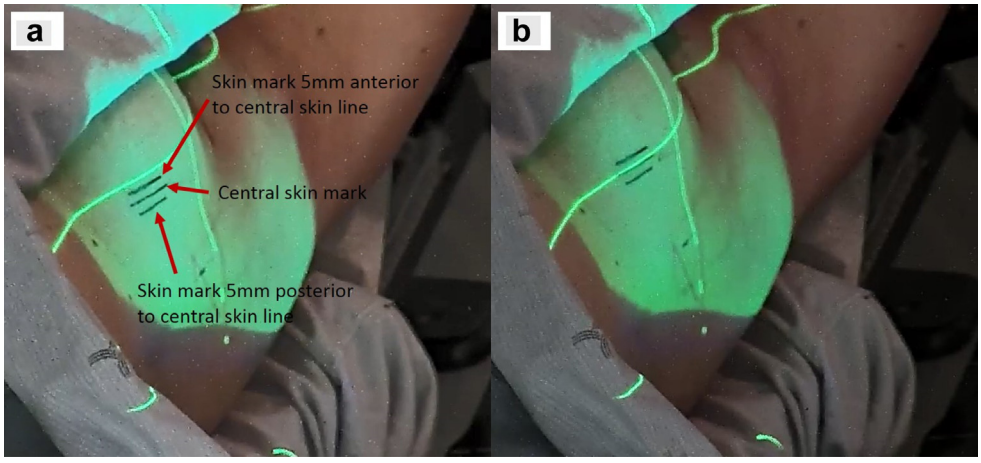

Figure 1 Tangential treatment of left breast showing skin marks relative to coronal laser. Lateral light field is projected on skin. (a) Skin marks relative to coronal laser during free breathing. (b) Skin marks relative to coronal laser during breath hold. With coronal laser aligned with central line on skin, beam is manually turned on.

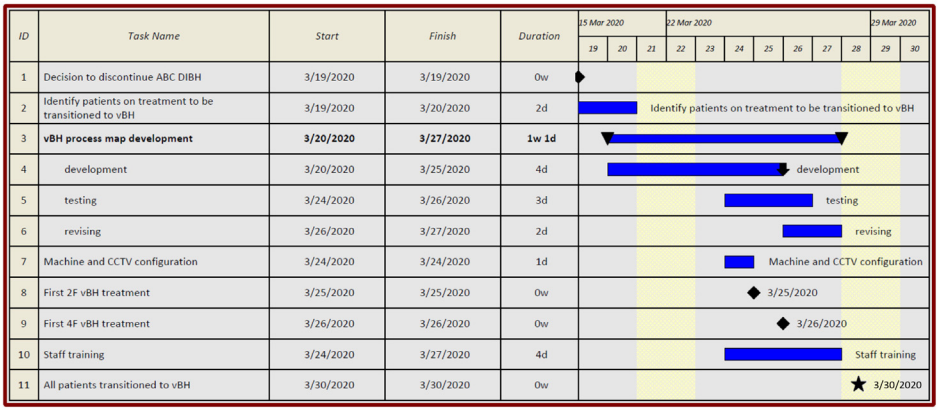

Figure 2 Voluntary breath hold (vBH) implementation timeline for patients with breast cancer simulated with moderate deep inspiration breath hold (mDIBH) and currently on treatment using the Active Breathing Coordinator (ABC) device.

previous requirement using the ABC device and was established to facilitate efficient delivery. Patients were also required to understand the breathing instructions to be eligible for vBH. If both of these eligibility criteria were met, then patients were coached on how to breathe (through mouth or nose according to patient comfort and with relaxed shoulders and back). vBH reproducibility was assessed by monitoring the marks on patients' skin relative to the coronal laser before CT acquisition. Relevant information from the vBH training at the time of simulation was transcribed to the patient treatment setup note and included maximum breath hold duration, tattoo table heights for free breathing, and vBH.

Implementation—Treatment Delivery

Patient education

To prepare patients for the transition from the mDIBH to the vBH delivery technique, the treating radiation oncologist contacted each affected patient by phone in advance of the go-live date. Radiation oncologists explained the reason for this change in breath hold technique. Upon arrival at the treatment unit for the first vBH fraction, patients received a brief education session from the radiation therapists. Treating radiation therapists were able to gauge patient comfort with the vBH technique and provide additional breath hold coaching as needed.

Staff education

Staff education sessions for radiation therapy team members were coordinated on a treatment unit using a staff volunteer patient to simulate the process. vBH was implemented on a single linear accelerator initially to maintain a consistent treatment team. As more staff gained experience with the vBH technique, vBH treatment was offered on a second linear accelerator.

Logistics

Implementation of vBH required the treating therapists to enter the treatment room extra times compared with the mDIBH treatment technique. For tangent and 4 field deliveries, 2 extra trips into the room were required, once to make marks on skin and a second time to adjust MV panel position to capture the MV images. For boost deliveries, radiation therapists needed to make a single extra trip into the room to mark the patient's skin. To accommodate the additional entries into the treatment room and skin marking steps, appointment times were increased by 10 minutes for tangent and 4 field treatments for the first fraction and increased by 5 minutes for subsequent fractions. Boost appointment times were increased by 5 minutes. It is anticipated that the appointment times will be returned to their original duration once the technique is fully established.

To support this practice change, some additional machine configuration changes were required. The in-room lasers were configured to remain on for the duration of a typical breast treatment. Preset positions of the CCTV cameras were saved on each unit to best view the skin marks relative to the coronal laser.

Discussion

The inherent differences between the ABC and the vBH techniques is acknowledged. The most significant challenge is anticipated for the patients simulated using the ABC system but receiving treatment using the vBH technique. For this reason, skin marks included 3 parallel lines: the central line to be aligned with the coronal laser while in breath hold, a line 5 mm anterior to the central line, and a line 5 mm posterior to the central line. This generous skin mark threshold was included in the process to accommodate any patients whose breath hold with the vBH technique differed greatly from the ABC technique. The ABC system is configured for each patient to hold their breath at 80% of the maximum inhalation volume. For some patients being coached into a voluntary breath hold, it may be difficult to appreciate the 80% maximum inhalation threshold. The tendency for some patients was to overshoot the displacement between the free breathing and breath hold tattoo table height. Additional coaching was required such that patients were able to better match the breath hold achieved at CT simulation. The $\pm$5-mm skin mark thresholds were found to be unnecessary, as patients were able to execute the vBH technique reproducibly. Challenges of this nature are not anticipated for patients who were CT simulated and treated in a vBH state.

At the time of writing, 7 patients have been CT simulated using the vBH technique and 80 vBH fractions have been delivered. Radiation therapy team members report a smooth roll out of this rapid technique transition. No patients who have been simulated using the vBH technique have initiated treatment yet.

Conclusions

Quality care in the context of breast cancer radiation therapy means continuing to offer cardiac sparing treatment techniques during the COVID-19 pandemic. Our radiation medicine program was able to respond quickly and efficiently to the recommendations from the global radiation oncology community and transition breast radiation therapy using the ABC system to a deviceless vBH technique. In total the transition took 7 clinical days of considerable effort, with team members from radiation oncology, radiation therapy, and medical physics working cohesively. On the eighth day all patients with breast cancer previously on treatment using the ABC device were transitioned to the vBH delivery technique and CT simulation for eligible patients was performed with the vBH technique.

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