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Concerns for activated breathing control (ABC) with breast cancer in the era of COVID-19: Maximizing infection control while minimizing heart dose --Manuscript Draft--

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Title: Concerns for activated breathing control (ABC) with breast cancer in the era of COVID-19: Maximizing infection control while minimizing heart dose

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1 Active Breathing Control (ABC) devices employ moderate deep inspiration breath hold (DIBH)
2 techniques in order to spare cardiac structures from dosing in left breast cancer (LBC) patients and
3 is more commonly practiced than prone positioning¹. ABC also helps in reducing dose to other
4 organs at risk, including lungs and liver². However, in the era of the COVID-19 pandemic, there are
5 concerns regarding the safety of using such devices with risks of transmission amongst multiple
6 patients, especially since the virus has a relatively high transmission rate and increased risk for
7 fatality for elderly patients³. This issue is particularly poignant to cancer patients who may be
8 immunocompromised and are at increased risk of invasive ventilation, ICU admission, or death (39%
9 vs 8%) with COVID-19⁴. In addition, alternatives to ABC, such as prone positioning, may provide
10 comparable benefits to ABC without placing LBC patients in situations at risk for direct exposure
11 from shared respiratory devices.

12 At our institution, we utilize Active Breathing Coordinator™ (Elekta; Stockholm, Sweden) for our LBC
13 patients. We previously published the results from a prospective trial using this device in which we
14 demonstrated a median reduction in mean heart dose (MHD) of 1.7 Gy with a 8-year locoregional
15 relapse rate of 7 percent⁵. Additionally, a systematic review of ten studies showed similar results with
16 DIBH, including a reduction of MHD up to 3.4 Gy, translating to a 13.6 percent decrease in risk of
17 heart disease⁶. This includes reduction of dose to the left anterior descending artery, with mean dose
18 reduced by nearly half and coronary events at 10 years down to 2.55 percent from 4.03 percent⁷.

19 Respiratory droplets are one of the main methods of transmitting the SARS-CoV-2 virus⁸. These can
20 be generated through coughing, sneezing, mouth and nose breathing, and talking. The size and the
21 number of droplets can vary based on the expiratory activity, the region of origin in the respiratory
22 tract, and the type of pathogen⁹. SARS-CoV-2 particles have had reported diameters ranging from
23 0.06 to 0.14 microns¹⁰. SARS-CoV-2 viral particles in aerosols can remain viable for up to 3 hours
24 and up to 72 hours on plastic and stainless steel surfaces¹¹. Aerosol models in healthy humans have
25 measured droplets from coughing as small as 0.1 microns, with the vast majority (97 percent) of
26 droplets as submicron in size¹². Viral aerosols, such as those generated by influenza, tend to skew
27 towards this submicron size distribution¹³.

28 The Active Breathing Coordinator™ utilizes a mouthpiece and filter kit which are designed for single
29 patient use. The ViroMax® viral/bacterial filter is constructed of a Styrene-Acrylonitrile Copolymer
30 which supports the filter media constructed from a blend of modacrylic and polypropylene fibers.
31 This has been tested and certified to >99.99% viral and >99.999% bacterial efficiency (FDA GMP,
32 ISO 13485:2016, FDA 510(k) clearance K063526). The filter has been tested to 0.1 micron size
33 particles which should technically provide adequate protection from transmission. Since the SARS-
34 CoV-2 virus may be as small as 0.06 microns, however, we have elected in our clinic to decide
35 whether or not to use ABC on a case-by-case basis due to these concerns.

36 As an extra precaution during this time of the pandemic, providers can consider alternatives to ABC.
37 Prospective trials comparing prone positioning vs DIPBH have found similar rates of cardiac
38 sparing^{14, 15}. A randomized clinical trial comparing voluntary DIBH with ABC DIBH found *no*
39 *significant differences* in doses to normal structures and was preferred by patients¹⁶. Both prone
40 positioning and voluntary DIBH can provide cardiac sparing comparable to ABC, and droplet
41 precautions do not have to be considered. During this current pandemic, our institution has been
42 favoring prone positioning over ABC for cardiac sparing. Prone positioning is not ideal for all LBC
43 patients, however, including for those needing regional nodal irradiation, very medial or lateral
44 lumpectomy cavities, and for situations where anterior displacement of the heart towards the chest
45 wall may not lead to effective cardiac sparing¹⁷. Therefore, one can consider simulating patients in
46 both prone and supine positions and selecting a treatment plan that is most suitable for the patient.

1 In addition, emphasis should be placed on optimizing treatment planning techniques such as field-in-
2 field and IMRT¹⁸.

3 In summary, the COVID-19 pandemic gives radiation oncologists an opportunity to evaluate our
4 standard practices and create institutional guidelines taking into account: 1) the size of SARS-CoV-2
5 virus and 2) the type of device used for respiratory gating, in order to determine the risk-benefit ratio
6 acceptable for our patients during this time. Alternatives to ABC, including voluntary DIBH, prone
7 positioning, and optimizing treatment planning should also be considered to mitigate risk between
8 patients.

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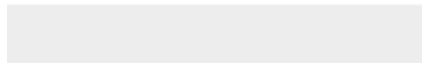


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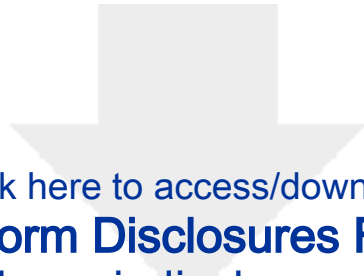
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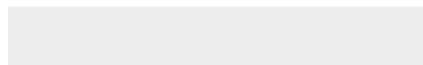


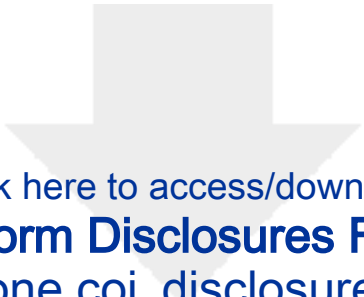
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