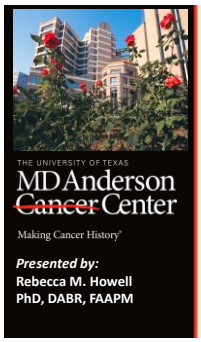
Practical Implementation of Deep Inspiration Breath Hold Techniques for Breast Radiation Therapy

Session Introduction

- DIBH was discussed >10 years ago in the AAPM Task Group 76 report but is still not the standard of care in many clinics, which may be partially because of challenges associated with its implementation.
- *Therefore*, this session will focus on how to clinically implement four DIBH techniques:
  1. Active breathing control (Daria Comsa, PhD)
  2. Spirometric motion management (Scott Hadley, PhD)
  3. 3D surface image-guided (X. Lily Tang, PhD)
  4. Self-held breath control with respiratory monitoring and feedback guidance (Kent Gifford, PhD)



Dosimetric Benefits of DIBH for Breast Radiation Therapy

Deep Inspiration Breath Hold (DIBH)

- Patient is simulated and treated during the deep inspiration phase of the breathing cycle.

Anatomic changes:

- Air is drawn into the thoracic cavity
- Diaphragm contracts and descends
- Abdomen is forced inferiorly and anteriorly
- Intercostal muscles contract
  - Ribs are pulled superiorly and anteriorly
  - Thorax diameter is increased anteriorly and laterally

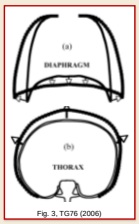
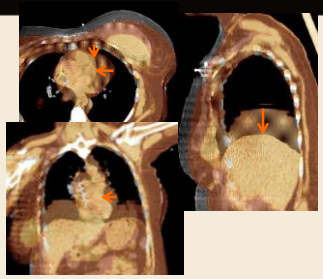


Fig. 3, TG76 (2006)

Anatomic Changes During DIBH - Heart

- Registered images from CT scans in DIBH [grayscale] and free-breathing (FB) [orange] modes.

Heart displaced posteriorly, inferiorly, and to the right.



Anatomic Changes During DIBH - Heart

- Heart displacement during DIBH results in less heart volume included in breast radiation fields.

How much less? >1 cm

- Comsa *et al*. (2014) reported maximum linear distances of heart within tangential breast fields was 1.6 cm for FB and 0.4 cm for DIBH.

Dosimetric Consequences of DIBH - Heart

- Numerous studies have demonstrated a decrease in mean heart dose of **37%-75%** for FB versus DIBH (review by Latty *et al.* 2014).
- Other studies have reported decreases in several additional dose-volume metrics, e.g., Comsa *et al.* 2014.

Metric	FB	DIBH
Mean Dose (Gy)	3.05 ± 1.12	1.16 ± 0.39
V_{30Gy} (%)	2 ± 2	0.04 ± 0.07
V_{10Gy} (%)	6 ± 3	0.9 ± 0.9

Data from Table 2, Comsa et al. 2014

Anatomic Changes during DIBH - Lungs

How much dose the lung volume increase?

- In a large clinical study of breast cancer patients, Nissen *et al.* (2012) reported ipsilateral lung volume was ~2X greater for DIBH compared with FB.

Lung Metrics	DIBH Left-Sided	FB Left-Sided
n	144	83
Volume median (cc)	2156	1247
Volume range (cc)	(1520 – 3120)	(670 – 1666)

Dosimetric Consequences of DIBH - Lungs

- Comsa *et al.* (2014) reported a statistically significant decrease ($p<0.001$) in lung dose-volume metrics.

Lung Metrics	FB	DIBH
Mean Dose (Gy)	14.26 ± 2.83	11.16 ± 1.99
V_{20Gy} (%)	28 ± 6	22 ± 5
V_{10Gy} (%)	35 ± 6	29 ± 5
V_{5Gy} (%)	45 ± 6	40 ± 5

Data from Table 2, Comsa et al. (2014)

- Similar findings were reported in other studies, e.g., Remouchamps *et al.* (2003)

Summary

- **During DIBH:**
  - The heart is displaced, increasing the distance between the heart and the breast/chest wall tissue.
  - Air is drawn into the thoracic cavity, increasing the total lung volume.
- These anatomic changes lead to **improved dose volume metrics** for both the heart and the lungs for DIBH compared with FB breast radiation therapy.

Up Next…

Four DIBH Techniques:

1. **Active breathing control**
2. **Spirometric motion management**
3. **3D surface image-guided**
4. **Self-held breath control with respiratory monitoring and feedback guidance**

Topic Overview:

- **Technical aspects**
- **Simulation and treatment workflow**
- **Commissioning and routine quality assurance**
- **Practical tips**

References

- AAPM Task Group 76 - The Management of Respiratory Motion in Radiation Oncology. Section 6.C. Breath Hold Methods (2006)
- D. Latty, K.E. Stuart, W. Wang, V. Ahern, "Review of deep inspiration breath-hold techniques for the treatment of breast cancer," J Med Radiat Sci 62, 74-81 (2015).
- D. Comsa, E. Barnett, K. Le, G. Mohamoud, D. Zaremski, L. Fenkell, Z. Kassam, "Introduction of moderate deep inspiration breath hold for radiation therapy of left breast: Initial experience of a regional cancer center," Pract Radiat Oncol 4, 298-305 (2014).
- H.D. Nissen, A.L. Appelt, "Improved heart, lung and target dose with deep inspiration breath hold in a large clinical series of breast cancer patients," Radiother Oncol 106, 28-32 (2013).
- V.M. Remouchamps, F.A. Vicini, M.B. Sharpe, L.L. Kestin, A.A. Martinez, J.W. Wong, "Significant reductions in heart and lung doses using deep inspiration breath hold with active breathing control and intensity-modulated radiation therapy for patients treated with locoregional breast irradiation," Int J Radiat Oncol 55, 392-406 (2003).