

DIBH with Align RT Vs Assisted Respiratory Module



Dr. Ashish Rustogi
Consultant and Head
Department of Radiation Oncology
Bahrain Oncology Centre
King Hamad University Hospital
Kingdom Of Bahrain



Disclosures :-

- Sponsorship from Vision RT for this talk

Dept of Radiation
Oncology





Motion
management
in BOC

Spoilt for Choices



Motion management in BOC

Spoilt for Choices



Breath Hold Techniques



Challenges of Motion Management

Expiratory or Inspiratory Breath Hold

- Lung Tumors
- Upper Abdomen Tumors



Closeness of Critical Structure

Inspiratory Breath Hold

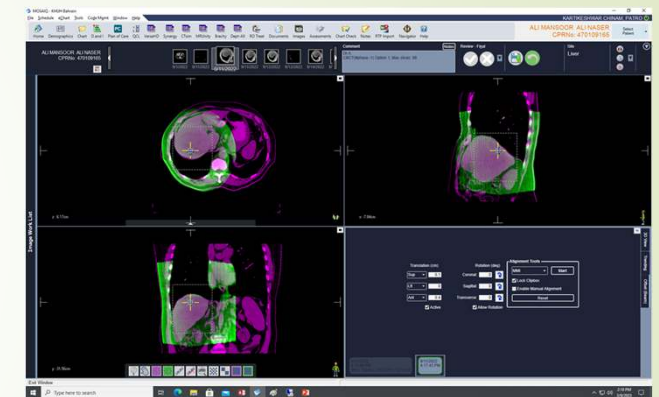
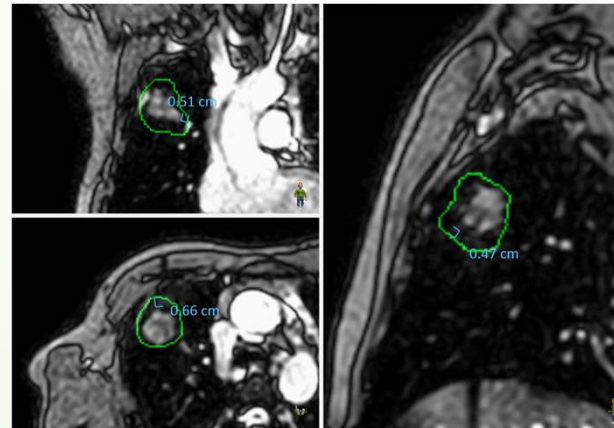
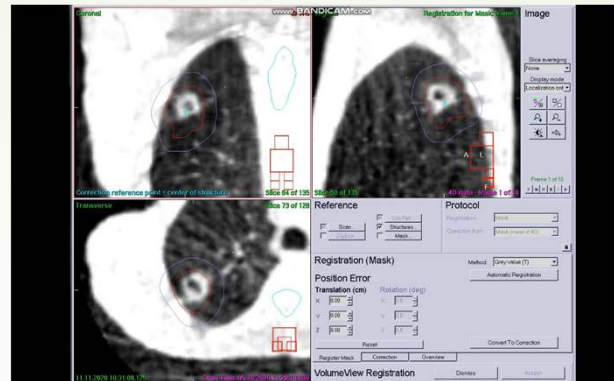
- Breast Cancer Radiation Therapy



Individualised treatment
Strategy

Tumor Motion Assessment

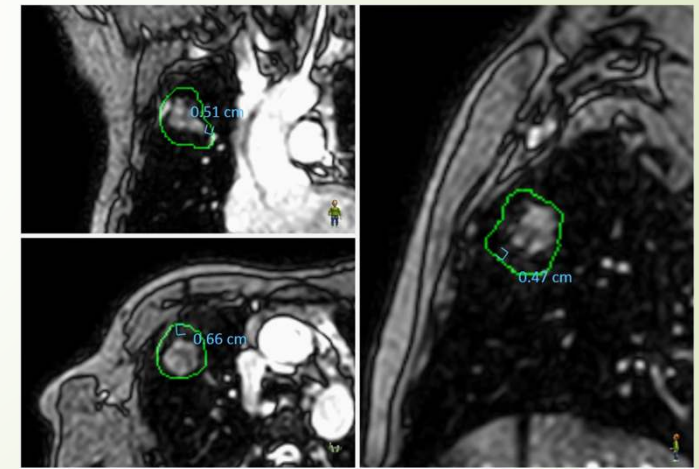
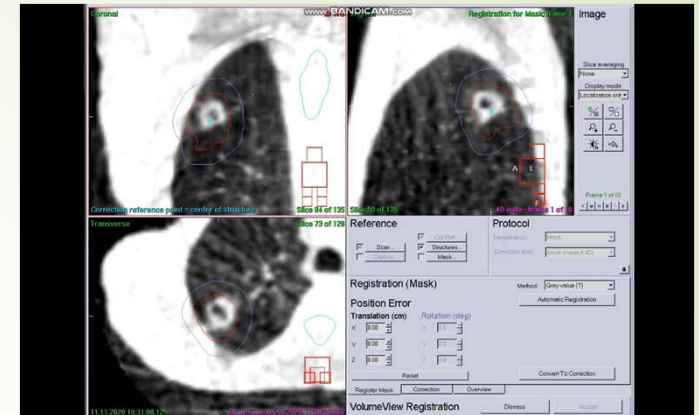
- SMART
- Pretreatment 4DCBCT
- Liver SBRT with ABC



Tumor Motion Assessment

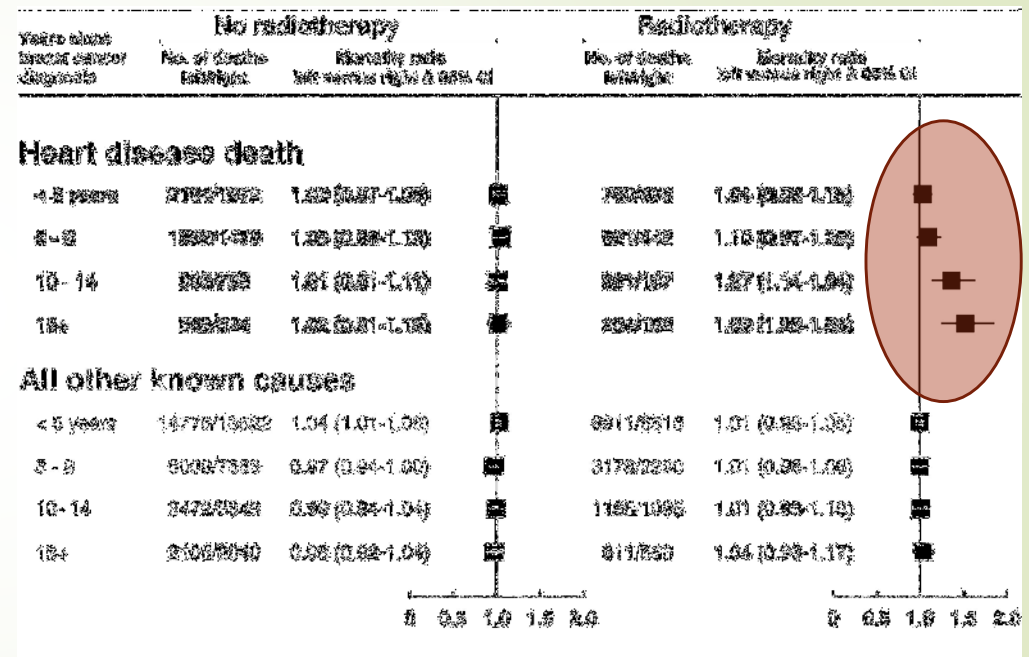
➤ Pretreatment – 4D CBCT(Symmetric)

➤ Realtime – MR Linac(Elekta)

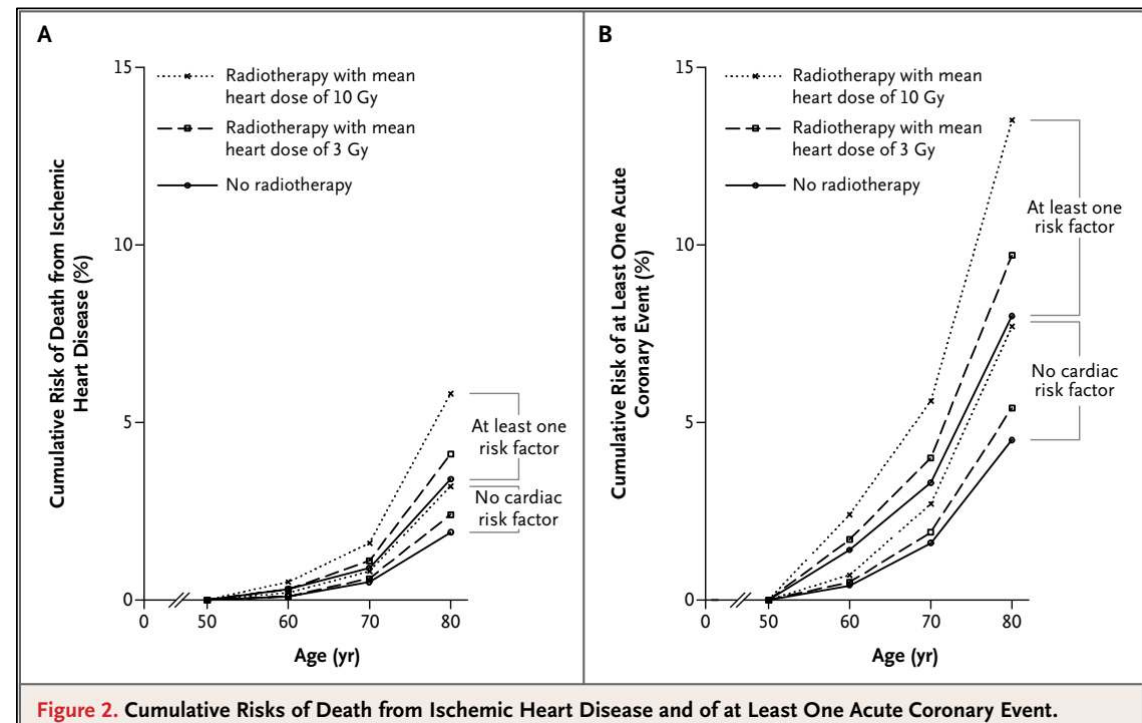
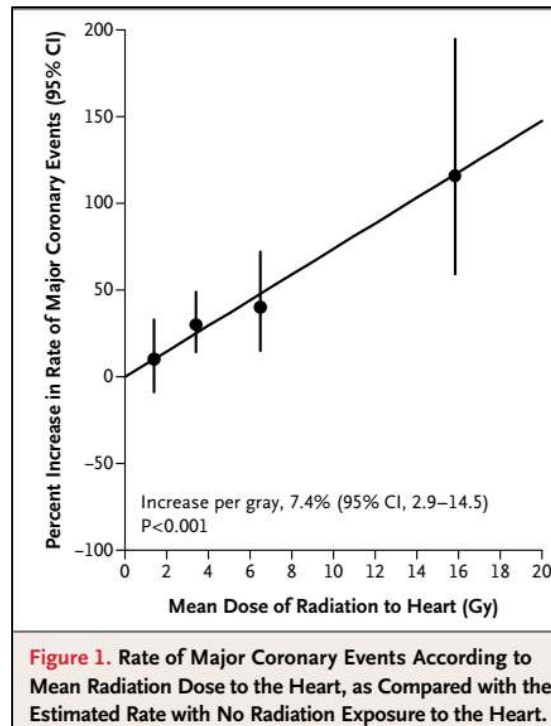


Long term Cardiac Mortality & Morbidity of Breast cancer Radiotherapy

- Radiation Therapy improves LRC from 26% to 7% and ARR mortality by 5.4%
- Mortality in patients with Left Vs Right Breast Cancer (p=0.02)

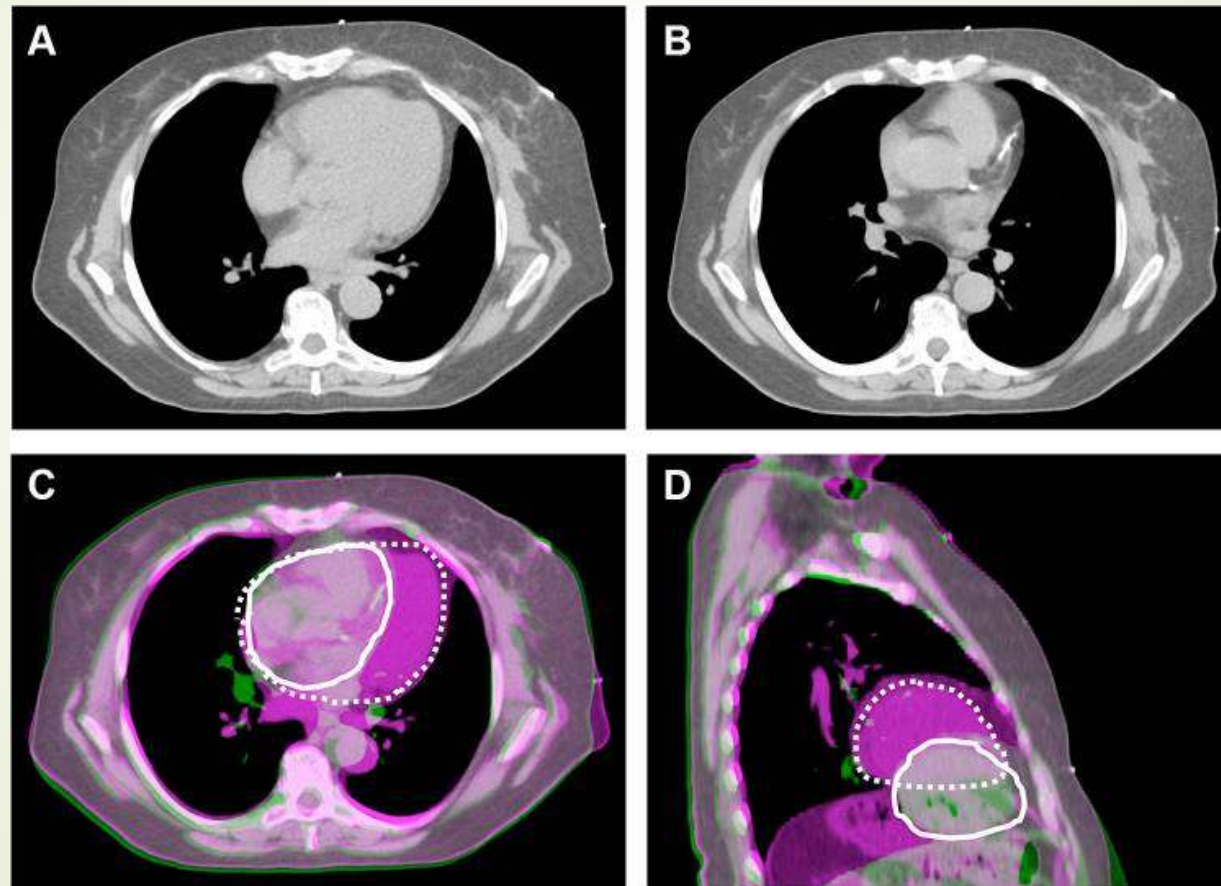


Long term Cardiac Mortality & Morbidity of Breast cancer Radiotherapy



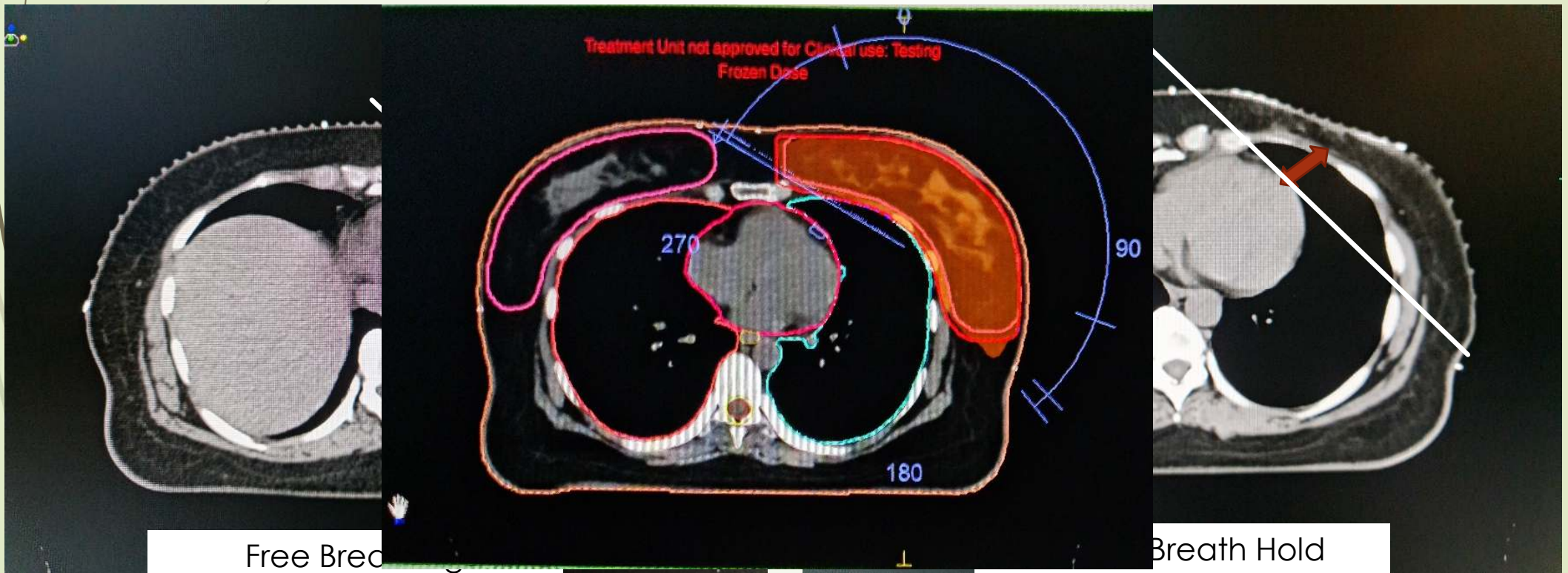
- Left Vs Right Breast Cancer (p=0.02)
- No apparent Threshold (ALARA)
- Every 1Gy increases incidence of Major CA by 7.4%
- Mean Heart dose a significant predictor

Breath Hold Techniques



Stowe et al. Breast Cancer . 2022; 14: 175–186.

Cardiac Sparing- Reducing Late Toxicities



Effect of DIBH on OAR dosimetry

Single-institution report of setup margins of voluntary deep-inspiration breath-hold (DIBH) whole breast radiotherapy implemented with real-time surface imaging

The data for effect on Long term Survivorship is yet to mature

Mean heart dose (Gy) in DIBH plan	1.7	—
Mean heart dose (Gy) in FB plan	4.8	—
Ipsilateral lung V20Gy (%) in DIBH plan	21.2%	21.5%
Ipsilateral lung V20Gy (%) in FB plan	26.3%	28.6%



Breath Hold Techniques

- What are the techniques?
- Comparison of two techniques?
 - Advantages and disadvantages of both?
 - Accuracy of positioning
 - Reproducibility
 - Effects on OAR doses
- Can they Complement each other ?

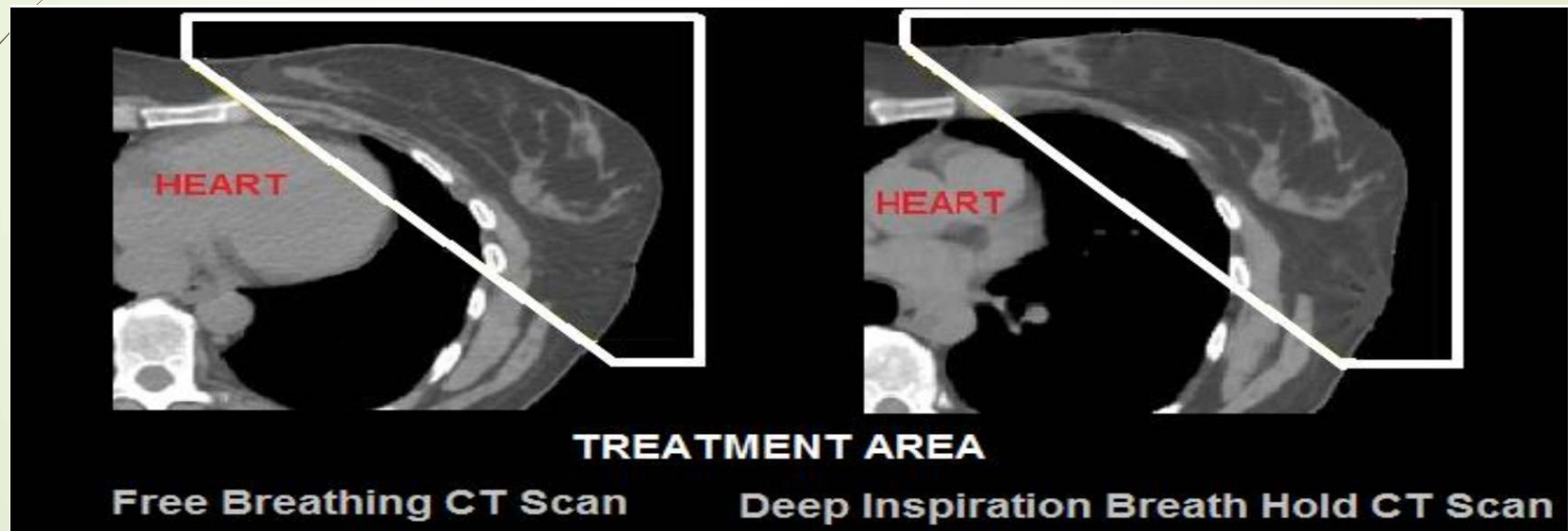


Breath Hold Techniques

- **What are the techniques?**
- Comparison of two techniques?
 - Advantages and disadvantages of both?
 - Accuracy of positioning
 - Reproducibility
 - Effects on OAR doses
- Can they Complement each other ?

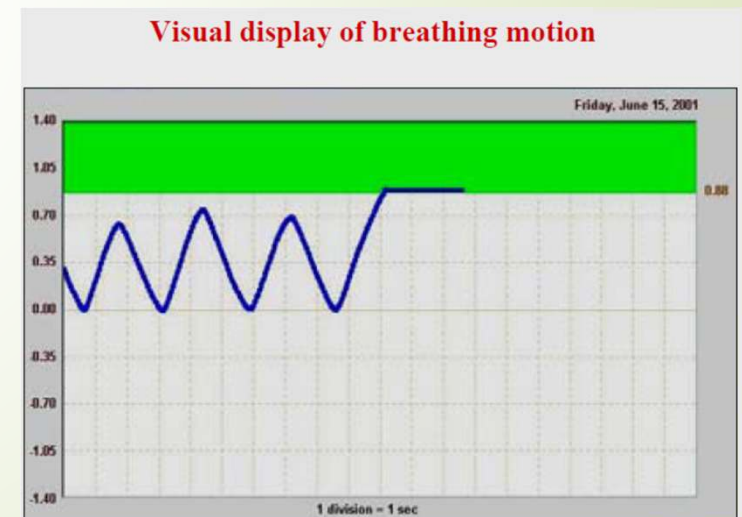
Breath Hold Techniques

- Voluntary Breath Hold
- Assisted or Involuntary Breath Hold



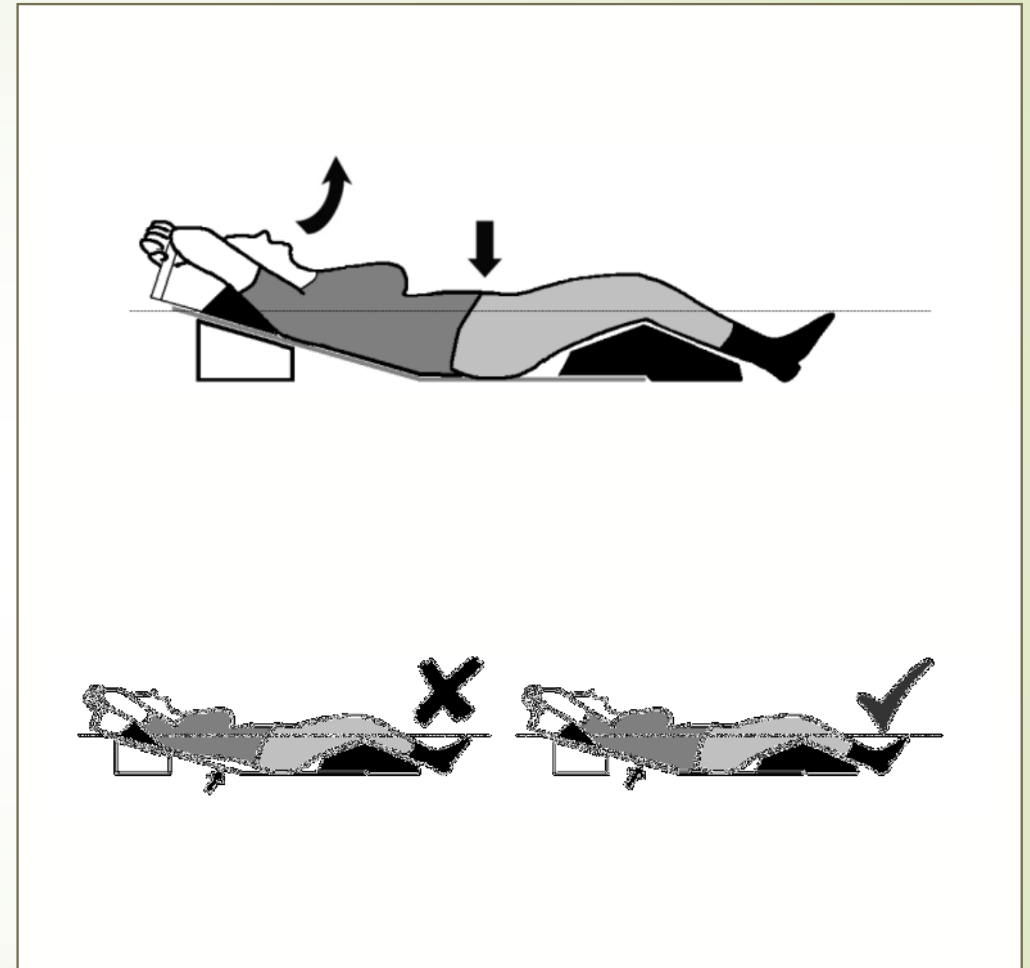
ACTIVE Breathing Control (mDIBH)

- Spirometer-based valve system to control to serve as a guide for DIBH.
- 75% of max Lung inspiratory volume.
- Robust reproducibility of Lung Volumes
- ABC intra-session lung volume variation was 1.8% (99 mL), about half of the 4.1% (226 mL) with VIBH.*
- Assisted Ventilation –So patient can be made compliant.
- Significantly decreases the heart dose as compared to Free Breathing



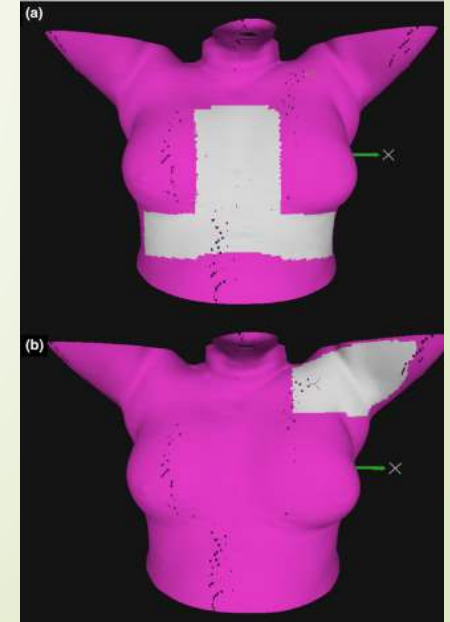
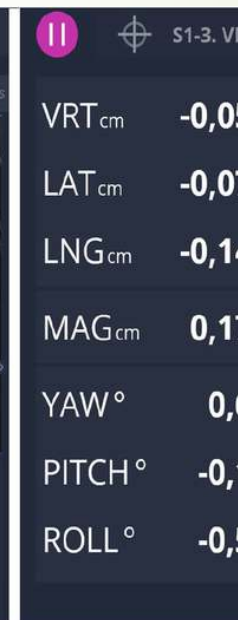
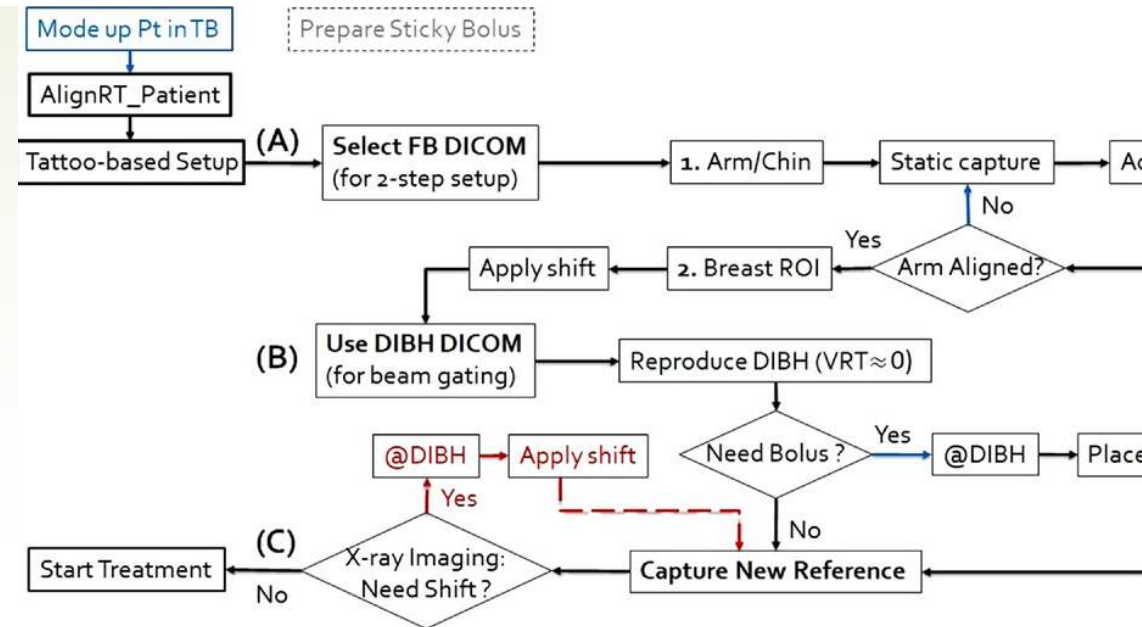
ABC

- No intrafraction monitoring
- Head and Arm position can vary leading to breast tissue displacement
- Arching cannot be detected
- Vertical and Super-inferior displacements go unnoticed
- Patients with Dentures and elderly women
- Breathing techniques makes a difference



Optical Surface Imaging based DIBH

- Monitors respiratory signal and patient positioning simultaneously
- Robust intrafraction monitoring of surface – correlating with initial patient set up and decreased intrafraction imaging
- Issues:
 - Patients with Large Breast with Folds
 - Very Obese patient
 - Non coplanar fields (PBI)





Breath Hold Techniques

- What are the techniques?
- **Comparison of two techniques?**
 - **Advantages and disadvantages of both?**
 - Accuracy of positioning
 - Reproducability
 - Effects on OAR doses
- Can they Complement each other ?

Evaluation of Breath Hold Techniques

Randomized Controlled Trial > [Radiother Oncol.](#) 2013 Aug;108(2):242-7.

doi: 10.1016/j.radonc.2013.04.021. Epub 2013 May 29.

The UK HeartSpare Study: randomised evaluation of voluntary deep-inspiratory breath-hold in women undergoing breast radiotherapy

Frederick R Bartlett ¹, Ruth M Colgan, Karen Carr, Ellen M Donovan, Helen A McNair, Imogen Locke, Philip M Evans, Joanne S Haviland, John R Yarnold, Anna M Kirby

- N=23 patients
- Compared vDIBH Vs ABC DIBH
- End points : Patient Comfort , treatment time ,Radiographer satisfaction

Evaluation of Breath Hold Techniques

- No difference in mean displacements
- No difference in normal tissue doses
- vDIBH less financial burden
- Significant difference in Patient satisfaction ($p=0.007$) and Radiographer Satisfaction score ($p=0.03$)
- Timings

	ABC _DIBH	vDIBH	pvalue
Planning CT Session	27 mins	24 mins	0.02
Treatment Set up	11 mins	9 mins	0.04
Mean Total time	19 mins	19 mins	NS



Breath Hold Techniques

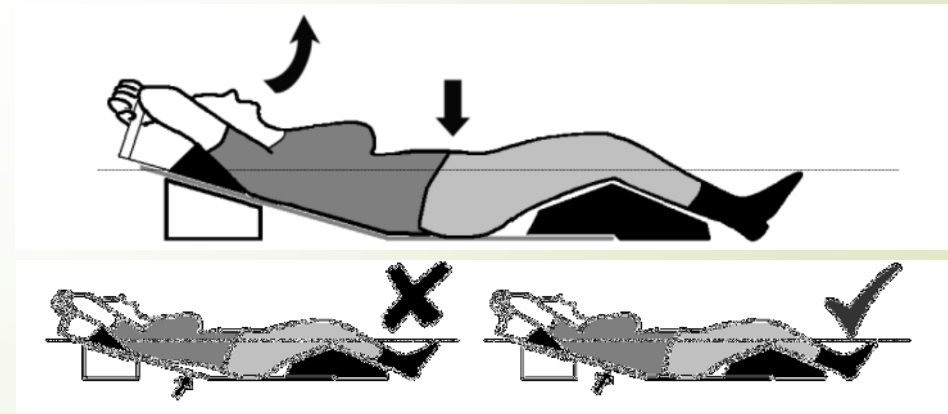
- What are the techniques?
- **Comparison of two techniques?**
 - Advantages and disadvantages of both?
 - Accuracy of positioning
 - **Reproducibility**
 - Effects on OAR doses
- Can they Complement each other ?

ABC Vs OSI based DIBH (Lung Volumes Vs Reference Surface Model)

Variability of Breast Surface Positioning Using an Active Breathing Coordinator for a Deep Inspiration Breath Hold Technique

Kristen McConnell ¹, Neil Kirby ², Karl Rasmussen ², Alonso N. Gutierrez ³, Nikos Papanikolaou ², Dennis Stanley ⁴

- Lung Volumes is not a perfect proxy for anatomical positioning
- Lung and chest wall position varies with breathing maneuver.
- Overzealous effort may lead to arching
- Variation of 2mm intrabreath hold and 2.5 mm intrabreath hold noted on MR studies



Variability of Breast Surface Positioning Using an Active Breathing Coordinator for a Deep Inspiration Breath Hold Technique

Kristen McConnell¹, Neil Kirby², Karl Rasmussen², Alonso N. Gutierrez³, Nikos Papanikolaou², Dennis Stanley⁴

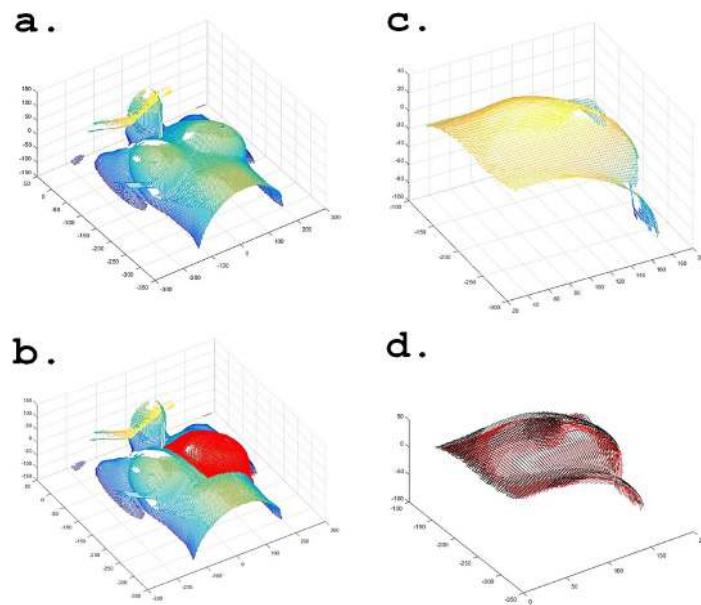


FIGURE 3: (a) Reference breath hold image as a 3D surface, (b) user-defined breast region overlaid on the reference image, (c) representative evaluation image of selected breast region, and (d) reference (red) and evaluation (black) images overlaid.

3D RMS Statistical Values

Average difference (mm)	7.12 ± 2.70
Maximum difference (mm)	11.72
Minimum difference (mm)	1.02
Median difference (mm)	7.67
Normalized inhalation threshold volume (L/L)	1.0 ± 0.0

- In spite of same Lung Volume 3D deviation difference across the whole volume was significant
- Becomes important in PBI and SIB boost



Stability and reproducibility of 6013 deep inspiration breath-holds in left-sided breast cancer

D. Reitz¹, F. Walter¹, S. Schönecker¹, P. Freisleder¹, M. Pazos¹, M. Niyazi¹, G. Landry¹, F. Alongi^{2,3}, E. Bölke⁴, C. Matuschek⁴, M. Reiner¹, C. Belka¹ and S. Corradini^{1*} 

Radiation Oncology (2020) 15:121

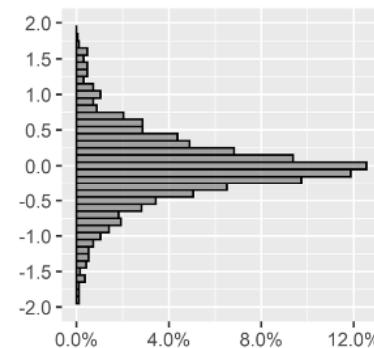
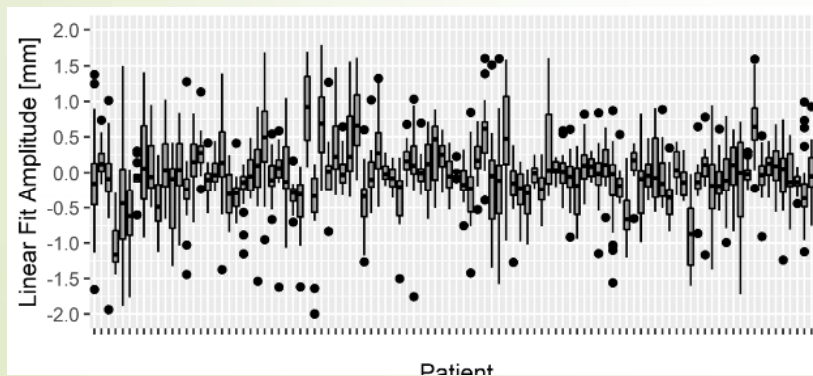
N=103 patients

Age : 32-80 years (Mean 57.7 +/- 11 years)

Fractions : 1944 , Breath hold sessions 6013

Whole group:

- Mean: 1.3 mm \pm 0.6 (95%-CI: [0.5–2.6])
- Median: 1.2 mm. (p=0.4)



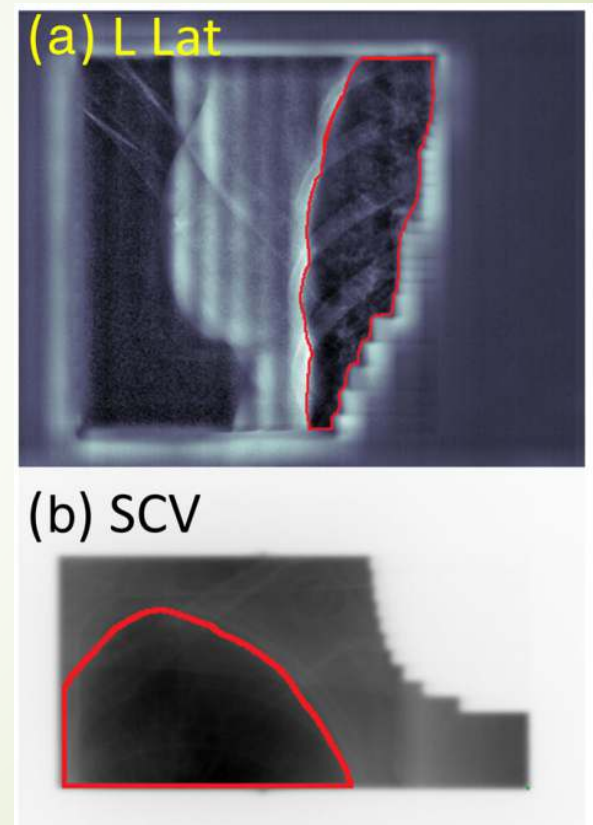
Individual patient:
Breathing amplitude between
individual patients were different
(p=0.007)

Comparison of the vDIBH vs aDIBH

Stability and reproducibility comparisons between deep inspiration breath-hold techniques for left-sided breast cancer patients: A prospective study

David Parsons¹ | Mindy Joo² | Zohaib Iqbal¹ | Andrew Godley¹ |
Nathan Kim¹ | Ann Spangler¹ | Kevin Albuquerque¹ | Amit Sawant³ |
Bo Zhao⁴ | Xuejun Gu⁵ | Asal Rahimi¹

- N= 8 Patients
- Crossover of DIBH Technique every 4 sessions
- 2D plans – Lt. Breast and SCV
- EPID Verification and in field Lung Volume recorded
- Coefficient of Variation among the Lung volumes Calculated

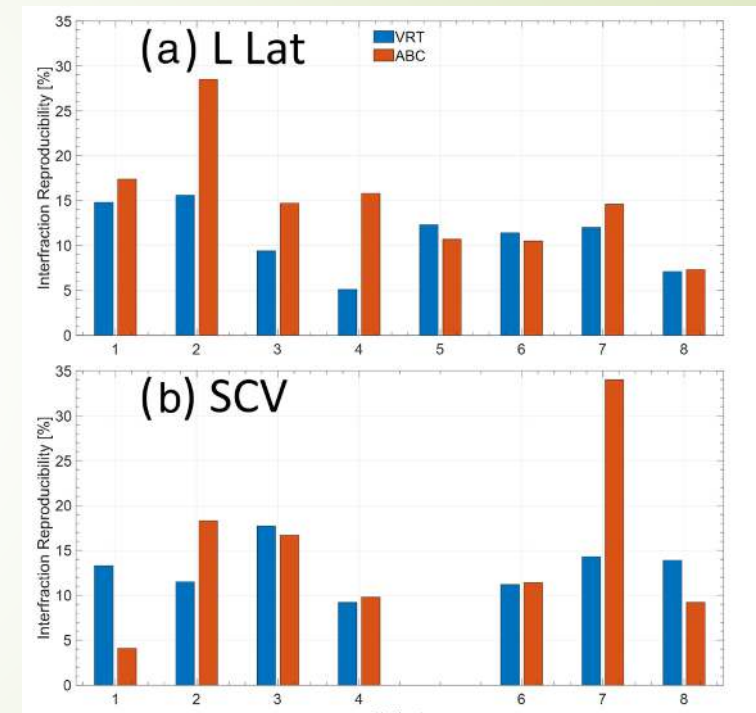


Comparison of the mDIBH vs ABC

Intrafraction Stability	Coefficient of Stability		p value
Lt Lat	1.26±0.67	1.46±0.92	P=NS
scv	1.52±0.70	1.55±0.78	P=NS

Interfraction Stability	Coefficient of Stability		p value
Lt Lat	11.0 ± 3.4%	14.9 ± 6.0%	P=NS
scv	13.0 ± 2.5%	14.8 ± 9%	P=NS

No significant difference in treatment duration and Set up time
Favoring vDIBH





Breath Hold Techniques

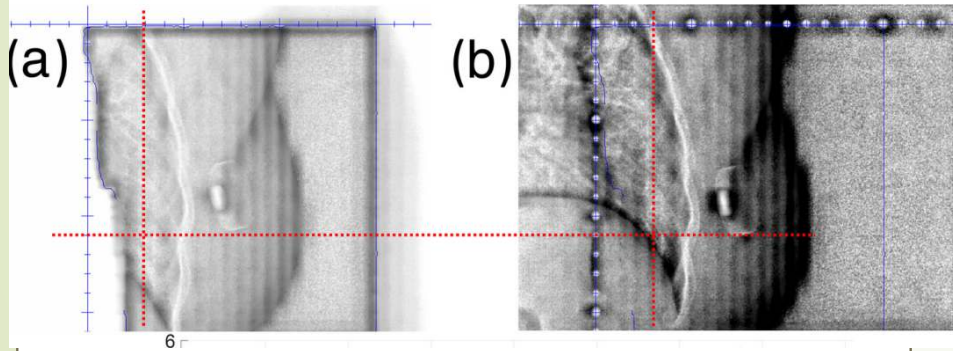
- What are the techniques?
- Comparison of two techniques?
 - Advantages and disadvantages of both?
 - Accuracy of positioning
 - Reproducibility
 - Effects on OAR doses
- **Can they Complement each other ?**

At BOC

Best of Both Worlds

Align RT + ABC™

- ABC provides Robust volume reproducibility
- AlignRT provides precise alignment and intrafraction monitoring, reducing the variability with respiratory maneuvers and BH drift





Conclusion

- The DIBH techniques offer proven advantages in breast radiotherapy via dosimetric sparing of organs-at-risk.
- Compared to ABC , OSI provides real-time tracking of breast position without dosimetric detriment to the patient.
- No significant difference in OAR sparing.
- OSI is a non invasive and patient friendly.
- Future directions to include possible heart positioning which has a variance of about 10 mm
- OSI , Combined with ABC and IGRT , may be a strategy to circumvent limitations of each .



The team that matters