Implementation of Tattooless 6DOF Breast Treatments Utilising AlignRT

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ICON CANCER CENTRE

INTRODUCTION

- The success of Deep Inspiration Breath Hold (DIBH) requires an accurate and reliable method for monitoring the level and duration of the breath-hold.
- Surface guidance improves patient positioning prior to image-guided radiotherapy (IGRT).
- With the installation of AlignRT at GCUH we introduced Breast DIBH without tattoos & using 6DOF couch corrections.

ICON SGRT experience

Vision RT Align RT

Varian Identify

GOLD COAST UNIVERSITY HOSPITAL (GCUH)

TRUEBEAM - Hyland

Installed August 2023

AlignRT Go-Live October 2023

All DIBH workload + Stereo BH using RGSC

TRUEBEAM - Jubair

Go-Live June 2024 with AlignRT

Will increase usage of AlignRT to include other treatment sites

ELEKTA- Orion

VersaHD with Hexapod Couch

Previously our DIBH ABC/Stereo workhorse.

Will be our electron/palliative machine

BACKGROUND

Prior to TrueBeam & AlignRT Installation

All DIBH patients were treated on our Elekta machines using Active Breathing Co-Ordinator (ABC)

4 Tattoos given to all Breast patients

Only 3DOF shifts were performed

Spotlight CBCTs for VMAT patients & kV/kV imaging for H-IMRT patients

CHANGES IN WORKFLOW & ASSOCIATED RISKS

Collision risk when imaging/treating with couch rotations applied	• Minimal risk due to laser guard & collision sensor system
Surface guided match providing incorrect initial position	• Risk of exceeding RTDs/going beyond allowable machine limits • VRT, LNG, LAT within 1cm & PITCH, ROLL, RTN within 2 degrees
Staff familiarity with new process	• All staff to complete AlignRT training & complete an end to end utilising phantom
Incorrect image matching	• Staff routinely perform 6DOF image matching for other treatment sites and therefore competent at assessing CBCTs for positional accuracy
CBCT not encompassing whole target volume	• PTVs > ~20cm requiring Extended CBCT only for patients > 60 yrs. old • Patients < 60 yrs. old with large PTVs not encompassed in CBCT had 3DOF corrections only + an INF kV Verif image
Increased imaging dose	• Extended CBCTs to be discussed with treating RO & noted in the Prescription

PILOT STUDY

- The aim of our pilot study was to assess the feasibility and efficacy of tattoo-less 6DOF implementation for breast patients.
- Our expectation was reduced patient time on bed and the minimisation of necessary shifts required.

❖ **10 Breast Patients**
❖ **15 Fraction Treatment**
❖ **Assessed over an 8-week period**
❖ **All imaged with Spotlight CBCT**

LEFT BREAST

6 Patients

- 5 DIBH
- 1 FB

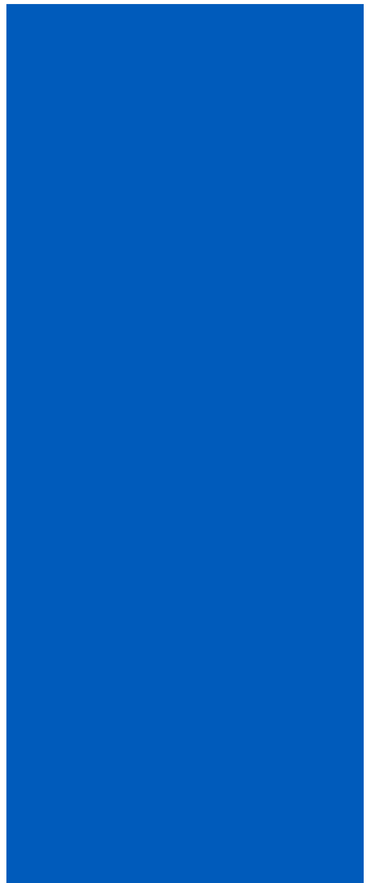
RIGHT BREAST

4 Patients

- 2 DIBH
- 2 FB

PILOT STUDY

4 Key Aspects



1. Tattoo-less patient pathway (no tattoos performed during simulation)
2. SGRT patient setup (patients breast surface used, no 4-point setup)
3. AlignRT sends 6DOF corrections to couch
4. 6DOF couch correction during image-guidance

METHOD

IMAGING SHIFTS

- Two couch positions obtained: Pre-Imaging & Treatment
- Difference in couch position is the treatment position minus the imaging couch position
- For each fraction the difference in couch position would be presented in 6 axes (Vert, Long, Lat, Pitch, Roll, Rot)
- Magnitude or 3-Dimensional (3D) vector was calculated
- The average 3D vector was compared to ICON centres without SGRT or the use of 6DOF.

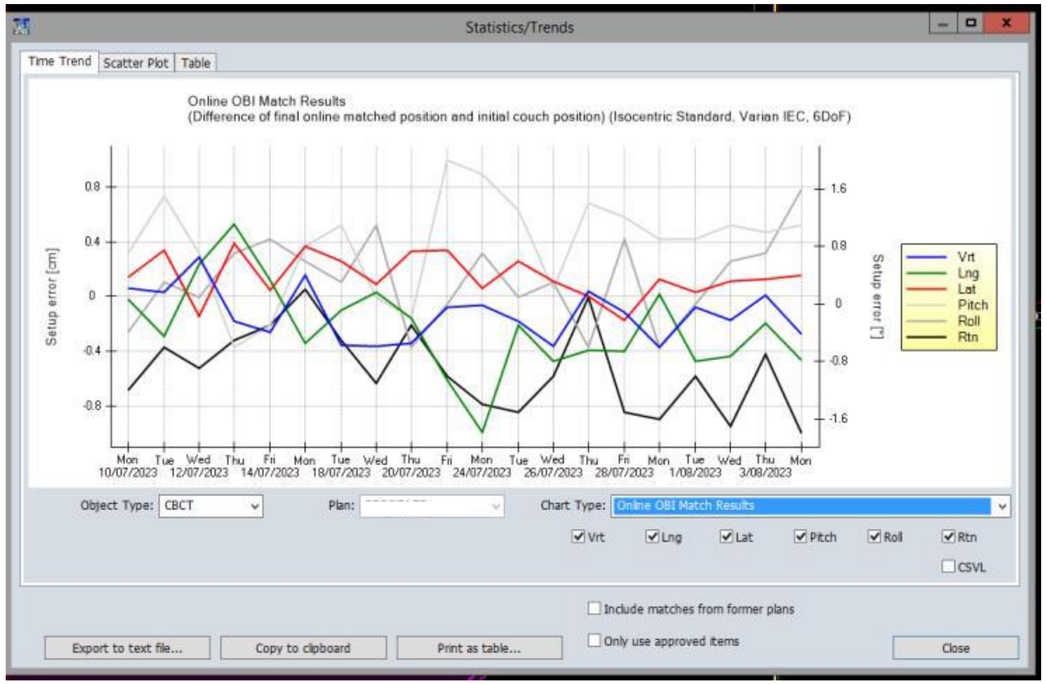
METHOD

- If SGRT setup + 6DOF correction is beneficial, in theory the difference between imaging and the treatment couch position should be smaller than a centre without SGRT & 6DOF.

- 3 Intervention Groups:
  - **AlignRT + 6DOF**
  - **AlignRT + 3DOF**
  - **3DOF Only**

- For the AlignRT + 3DOF & 3DOF Only groups the difference in couch positions were presented in Offline Review data obtained in ARIA

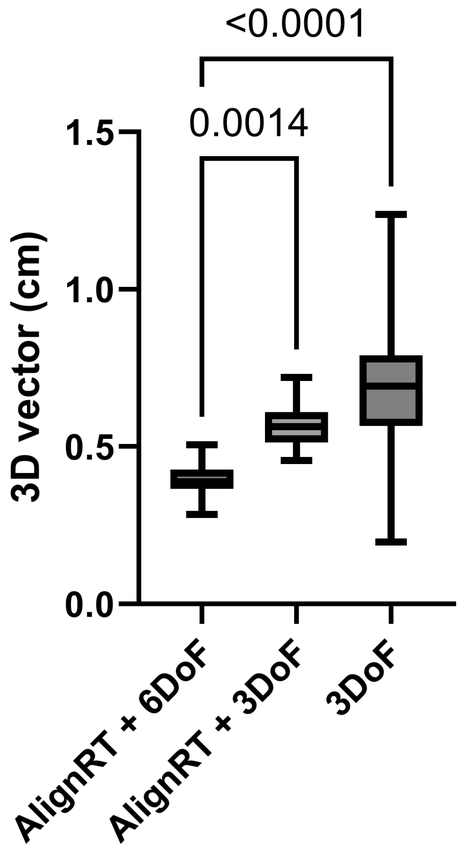
- We also assessed rotational shift reversals as we noticed a significant number of patients having rotational shifts in the opposite direction during IGRT



RESULTS

	Number of Fractions	Mean 3D Vector
AlignRT + 6DOF	150	0.27cm
AlignRT + 3DOF	305	0.43cm
3DOF Only	198	0.54cm

A one-way ANOVA was performed to compare the effect of each intervention on IGRT shift 3D vector. This revealed a statistically significant difference in 3D vector between at least two intervention groups ($p < 0.0001$).
Tukey's Test for multiple comparisons found that the mean 3D vector was significantly different between AlignRT+6DoF and AlignRT+3DoF ($p = 0.0014$) as well as AlignRT+6DoF and 3DoF intervention groups ($p < 0.0001$).



RESULTS

PATIENT SHIFT REVERSALS

Patient Shift Reversed

Patient ID	Pitch	Roll	Rotation
	33%	40%	40%
	33%	27%	33%
	0%	0%	100%
	13%	7%	40%
	0%	67%	33%
	13%	25%	13%
	33%	13%	27%
	13%	47%	40%
	33%	20%	27%
	7%	27%	40%
Total Average	23%	28%	38%

- The average % of re-corrections were 23%, 28% and 38% in the Pitch, Roll & Rotation respectively.
- Rotations were slightly larger than Pitch & Roll due to the patient highlighted with a 100% re-correction rate.

LESSONS LEARNED

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POST GO LIVE CASE REVIEW REGISTER

Review: Week 1

Week Summary

Date of review session	
New starts w/ SGRT this week	
DIBH patients on-treatment w/ SGRT	
Total patients on-treatment w/ SGRT	

Site Representative Update

Workflow challenges encountered and/or problem-solving. *E.g. Limited ROI visibility from gantry obstruction, patient contour change, irregular patient anatomy, hardware/software issues.*
Workflow/documentation changes proposed
Local training/support needs identified. *E.g. Additional staff to be trained, updates to training identified, vendor support required, SGRT techstream/REDi support required.*
•
TS representative comments
-

SGRT
Post Go-live Case Review Register

Purpose

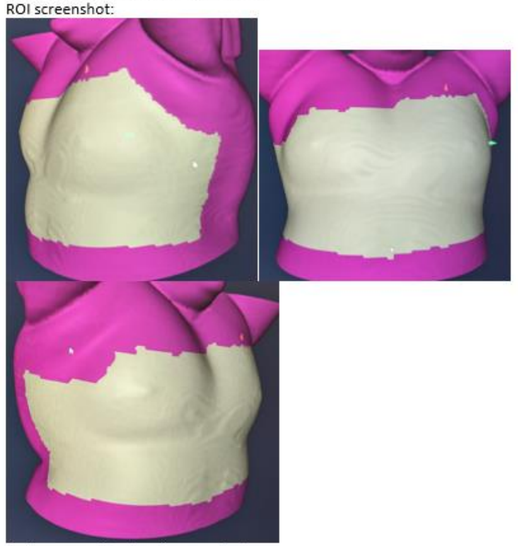
The purpose of this document is to provide evidence of appropriate SGRT utilisation at a departmental level following initial clinical release. Scheduled reviews should document consistent practice and problem-solving, as well as ensuring any required support or workflow improvements are appropriately actioned.

Department	GCUH
SGRT system	AlignRT
Go-live date	10/10/2023
Designated representative(s)	Laura Young

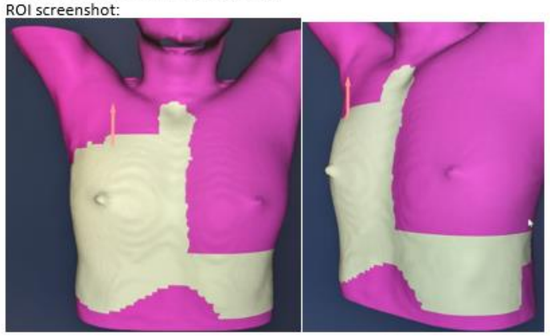
Schedule of Review Sessions

It is the responsibility of the reviewer(s) endorsed by the SGRT technical stream to coordinate the schedule of reviews in liaison with site representatives. Prior to each session, site representatives are to complete the associated review template within this document. An example of information to be provided is provided in Appendix 1.

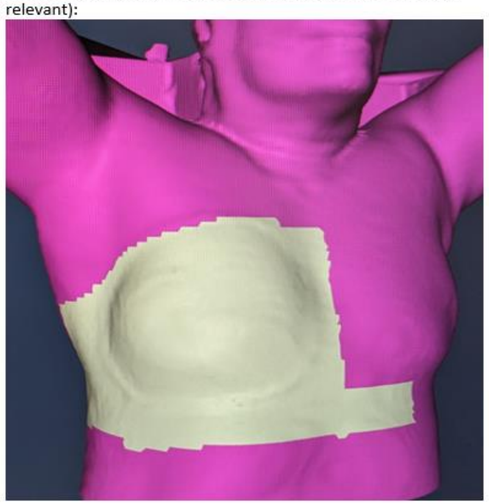
Week	Date of review session	Site representative(s) present	Reviewer(s) present
1	12/10/2023	Laura Young, Ange Carle	Cushla Edwards
2	20/10/2023	Laura Young	Cushla Edwards
3	27/10/2023	Onsite visit	Cushla Edwards
4	7/11/2023	Laura Young	Cushla Edwards
6	14/11/2023		
8	dd/mm/yyyy		

Site Representative to complete	Reviewer to complete
Patient ID: Treatment Site: L Breast DIBH + 6DOF ROI screenshot:  Online correction trend screenshot:	Reviewer feedback: This patient is quite large with quite a lot of tissue superiorly & not much contour change. Sue had initially made our ROI quite large but we have since altered it to crop a bit out of the superior portion as it was giving us flickering deltas in the LNG direction. On the deformation window this is where we noticed it was causing us to go out. She is also not very consistent. She has some good days & then not so good days. This was our first AlignRT patient who really struggled getting into BH. CE: Discussed removing ROI from lower chest, belly motion and quite flat

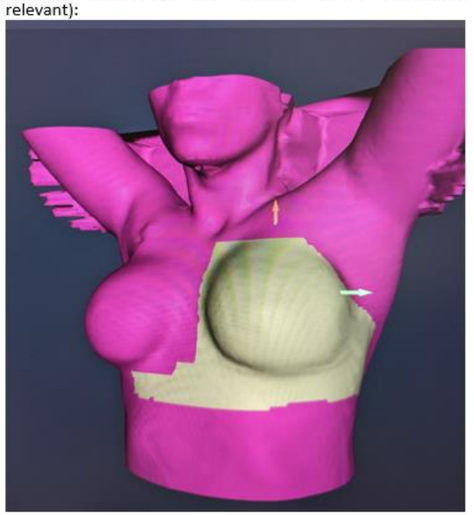
Session	Vrt [cm]	Lng [cm]	Lat [cm]	Pitch [°]	Roll [°]	Rtn [°]
Wed 11/10/	-0.24	-0.97	+0.38	+1.6	+1.0	+0.9
Thu 12/10/	-0.03	-0.16	+0.13	+0.9	+0.3	+0.1
Fri 13/10/2	+0.07	+0.05	+0.51	+0.3	+1.6	+0.5
Mon 16/10/	-0.33	-0.12	+0.49	+2.1	+0.4	-0.6
Tue 17/10/	-0.32	-0.51	+0.15	+1.0	+1.1	+1.1
Wed 18/10/	-0.07	-0.31	+0.52	+0.5	+1.8	+0.6
Thu 19/10/	-0.30	-0.33	+0.38	+1.5	+0.8	0.0

Site Representative to complete	Reviewer to complete
Patient I Treatment Site: R Breast DIBH + 6DOF ROI screenshot:  Online correction trend screenshot:	Reviewer feedback: Very flat chested. ROI was brought down to ribs on recommendation per vendor training. Also to include SN. The band across the bottom of the chest is essential due to the gantry & imaging panel position during our CBCT/obstructing the cameras. CE: Suggest removing ROI from SN. Arm position has not been great for this patient, impact of having ROI overlap with SB/Clavicles in inconsistent 6DOF shifts

Session	Vrt [cm]	Lng [cm]	Lat [cm]	Pitch [°]	Roll [°]	Rtn [°]
Thu 12/10/	-0.06	-0.14	+0.01	+0.2	0.0	+0.2
Fri 13/10/2	-0.10	-0.29	+0.08	+0.9	+0.8	-0.7
Mon 16/10/	-0.11	-0.09	+0.02	+0.5	+0.4	-1.1
Tue 17/10/	-0.12	-0.12	-0.02	+1.4	+0.5	+0.5
Wed 18/10/	-0.11	-0.19	+0.16	+1.9	+0.8	-0.7
Thu 19/10/	-0.12	-0.22	+0.17	+1.7	+0.3	+0.1

Site Representative to complete	Reviewer to complete
Patient Treatment Site: R Breast FB ROI screenshot (include original and updated surfaces where relevant):  Online correction trend screenshot:	Reviewer feedback: Consistent rotation noted on images. Hips in correct spot ie over to the left. Deformation window to be assessed.

Session	Vrt [cm]	Lng [cm]	Lat [cm]	Pitch [°]	Roll [°]	Rtn [°]
Mon 30/10/	+0.07	-0.43	+0.11	-0.3	+1.1	+0.4
Tue 31/10/	-0.08	+0.07	+0.10	-1.1	+1.1	+0.8
Wed 1/11/2	-0.19	+0.27	+0.22	-0.7	+0.5	+1.3

Site Representative to complete	Reviewer to complete
Patient Treatment Site: L CW/AX/IMN 6DOF ROI screenshot (include original and updated surfaces where relevant):  Online correction trend screenshot:	Reviewer feedback: On first day AlignRT was showing us excessive Pitch in both FB & BH. Everything looked like it was setting up nicely and ROI looked good (no ROI in weird places). Originally ROI was brought across contralateral breast to nipple. We decided to just deselect the Pitch and assess the image. Image looked good so we went ahead with treatment After treatment I brought the ROI over to ML to see if Day2 was better. Still pitch issues so not sure what is going on? The implant does look slightly different, not sure if thats an issue? Different implant shape, looks to have shifted slightly altering external body? LY mentioned shadowing along midline breast-. Adviced to adjust ROI here, consider capturing a new surface for remaining treatment.

Session	Vrt [cm]	Lng [cm]	Lat [cm]	Pitch [°]	Roll [°]	Rtn [°]
Tue 31/10/	-0.23	-0.08	+0.04	-0.2	-0.3	-0.3
Wed 1/11/2	-0.34	+0.13	+0.12	-1.2	-1.0	-1.0

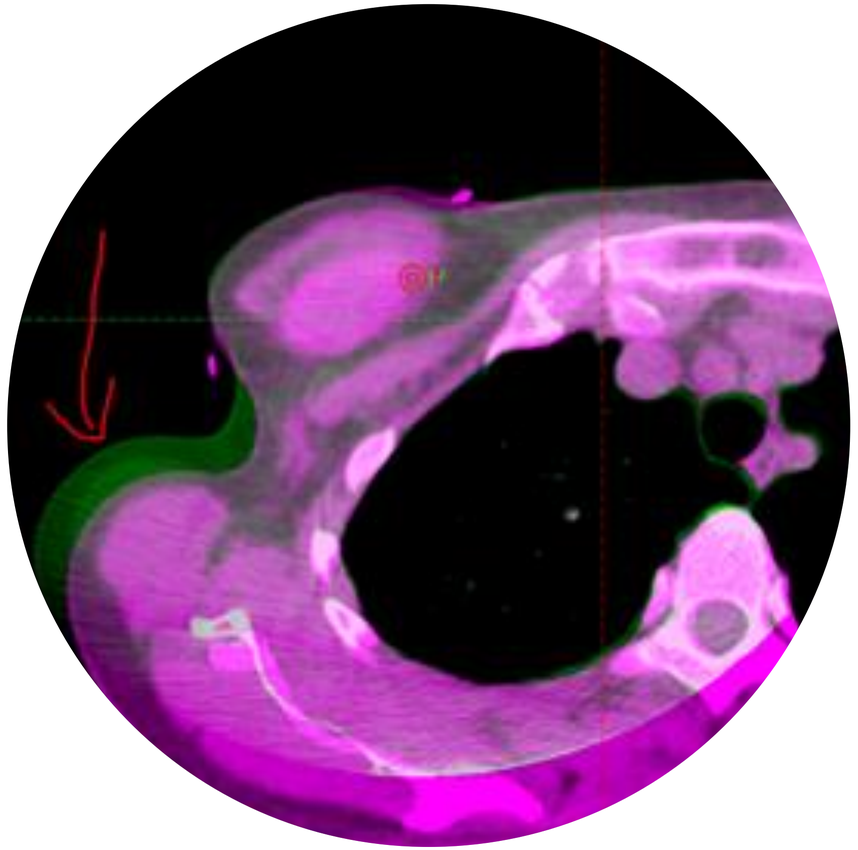
WHAT HAS HELPED US WITH PATIENT SETUP

VRT	
←RAISE BED	DROP BED→
LNG	
←MOVE PT INF	MOVE PT SUP→
LAT	
←PULL PT RIGHT	PULL PATIENT LEFT→
ROT	
←SHLDRS RIGHT/HIPS LEFT	SHLDRS LEFT/HIPS RIGHT→
ROLL	
←ROLL UP LEFT	ROLL UP RIGHT→
PITCH	
←PELVIS: FLATTEN BACK	PELVIS: ARCH BACK→

Visual representation of postural video. Obtained from https://www.visionrt.com/postural-video/

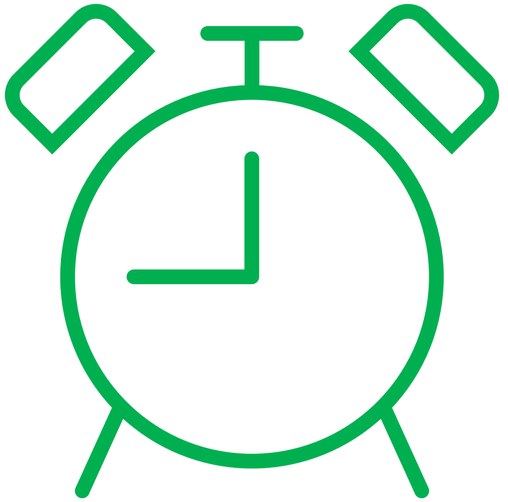
WHAT HAS HELPED US WITH PATIENT SETUP

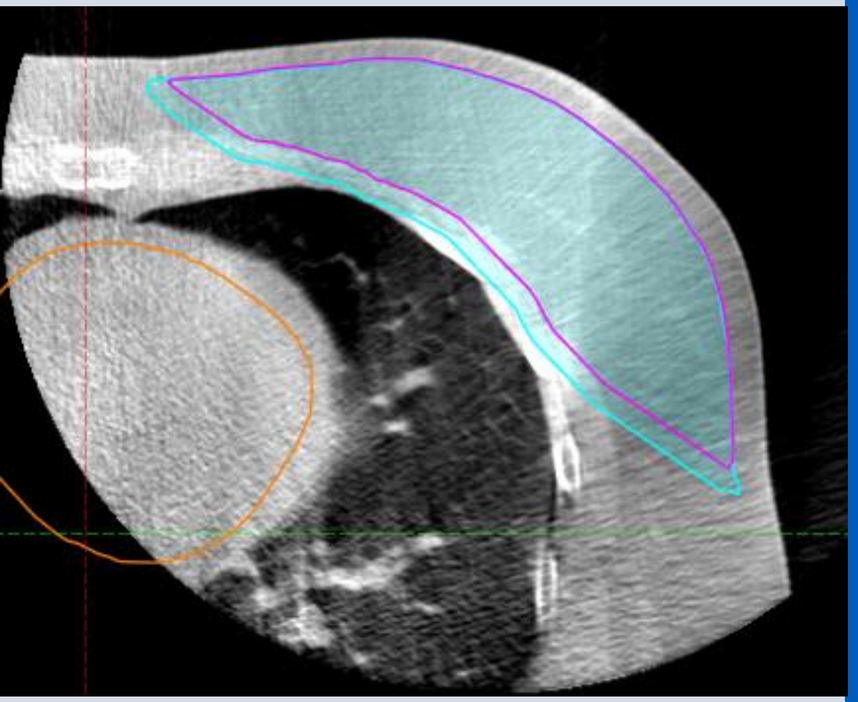
- Prior to AlignRT implementation we were only using Vacbags for Breast + SCF/Axilla treatments
- We initially discontinued Vacbag use with AlignRT
- Re-introduced Vacbags for all AlignRT patients after we noticed a trend with differing arm/shoulder position
- Minimising the use of Breast Board



HAVE WE REDUCED PATIENT TIME ON BED?

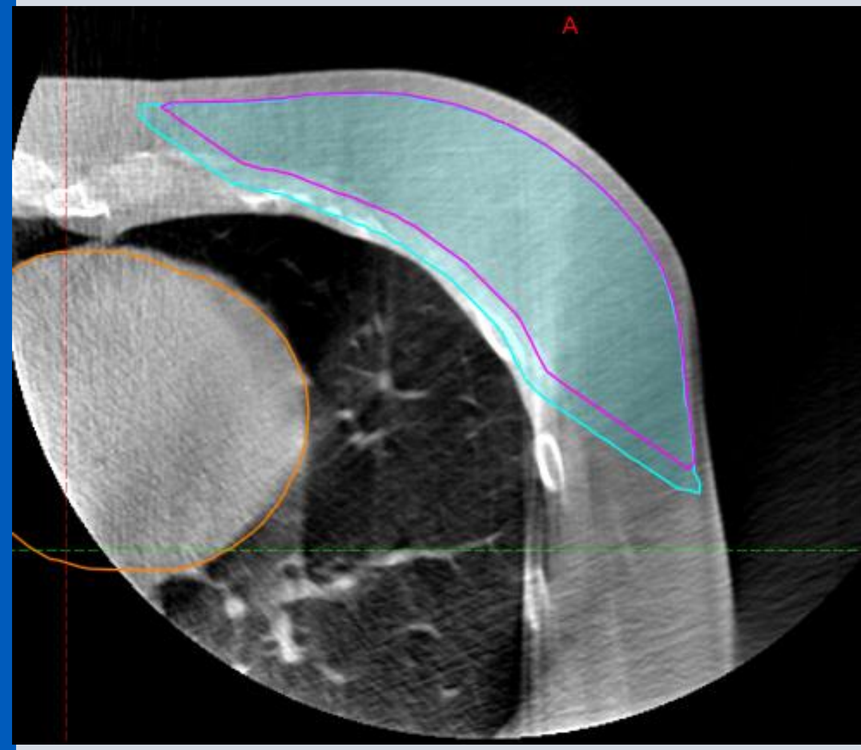
- AlignRT was new to all staff at GCUH & therefore a big learning curve for all of us
- Still in the process of training staff, which is time consuming
- Where we have saved time is there are fewer re-setups required with AlignRT





RGSC DIBH
V
ALIGNRT DIBH

- Our first AlignRT DIBH patient on a Breast Board
- Started as RGSC due to camera occlusion & staff confidence
- After 3# we changed over to AlignRT & updated our ROI
- Patient struggled getting into breath-hold with AlignRT initially. Previously using belly to push RGSC block up



THANK YOU

Tai Tran – Senior Medical Physicist

Cushla Edwards – National Manager of Radiation Therapy Education

Aidan Leong – Group Manager – RT Education and Training

SGRT Tech Stream – Ben Archibald-Heeren, John Shakeshaft, Lee Anderson, Mikel Byrne, Talia Jarema, Cushla Edwards & Tai Tran

OG Team HYLAND – Ange Carle, Stephanie Robinson, Pamela White & Siobhan Whiting

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