Enhancing Clinical Excellence: How SMC Leverages SGRT for Outstanding Radiotherapy Care as the First Tattoo-less Site in Southeast Asia and Malaysia on Varian Linac

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Sunway City Kuala Lumpur

Ng Hui Sin, Radiation Therapist

CANCER CENTRE, SUNWAY MEDICAL CENTRE, MALAYSIA

WORLD'S BEST HOSPITALS 2024–2026 Newsweek statista
SUNWAY MEDICAL CENTRE, SUNWAY CITY

WORLD'S BEST SMART HOSPITALS 2026 Newsweek statista
SUNWAY MEDICAL CENTRE

Sunway Medical Centre Overview

Sunway Medical Centre Overview

Radiotherapy Department

ONCOLOGISTS

8 Resident doctors

6 Visiting doctors

EQUIPMENT

4 Diagnostic Units

6 RT Treatment Units

TEAM SIZE

42 members, including

- 3 Patient liaison
- 13 Nurses & PCC
- 8 Medical Physicists
- 15 Radiation Therapists

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Technological Milestones in RTNM Department

OCTOBER 2016
TrueBeam STx & Biograph mCT 20 PET/CT

DECEMBER 2016
Flexitron Brachytherapy

AUGUST 2017
Intrabeam IORT

NOVEMBER 2017
Gamma Knife & Symbia Intevo SPECT/CT

SEPTEMBER 2019
Aquilion Lightning CT Simulator

DECEMBER 2019
Radixact Tomotherapy

JULY 2022
uMi 790 PET/CT

DECEMBER 2023
TrueBeam STx

SEPTEMBER 2025
Biograph Vision 600 PET/CT

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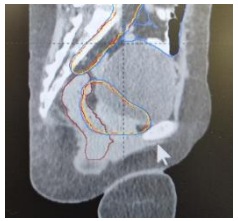
Background: The Importance of Precision in RT

Geometric Accuracy



- **Tumor Coverage:** Essential for maintaining target dose distribution and achieving optimal local control.
- **OAR Sparing:** Critical for minimizing radiation dose to surrounding Organs at Risk (OAR).
- **Setup Errors:** Even small deviations can lead to significant under-dosing of the target or over-dosing of healthy tissue.

High precision is the foundation for successful therapeutic outcomes and patient safety.

Advanced Modalities

- Modern techniques utilize highly conformal dose distributions with steep dose gradients.
- Increased complexity raises the demand for sub-millimeter patient positioning accuracy.

IMRT	VMAT
SBRT	SRS

The evolution of radiotherapy necessitates real-time verification and non-invasive positioning.

Traditional Setup Approach

Standard Methodology

For decades, radiotherapy centers have relied on manual, static positioning techniques that utilize external references.

- **Skin Tattoos:**
  Permanent ink marks applied during simulation to serve as daily setup markers.
- **Laser Alignment:**
  External room lasers aligned with skin marks for initial patient positioning.

Gold standard for consistency before 3D surface imaging.

Key Clinical Limitations

- **Permanent Cosmetic Impact**
  Lifelong physical reminder of the cancer journey; psychological burden.
- **Setup Variability**
  Errors caused by skin movement, weight changes, or fading marks.
- **Limited Real-time Monitoring**
  Inability to track intrafraction motion once the beam is active.
- **Patient Discomfort**
  Invasive tattooing process and anxiety regarding long-term marks.

Tattoo-less Radiotherapy Concept

Traditional Paradigm

Static Skin Markers: Permanent ink or tattoos used as fixed alignment points.

External Alignment: Reliance on room lasers matching skin marks.

Discrete Verification: Setup accuracy checked primarily at start of fraction.

Dynamic SGRT Evolution

Surface Anatomy: Utilizes thousands of 3D data points from patient's own skin.

Real-Time Guidance: 3D camera tracking compares live surface to CT reference.

Intrafraction Monitoring: Continuous sub-millimeter tracking during beam-on.

THE SHIFT

Transitioning from **static physical marks** to **dynamic digital guidance**: A patient-centered approach that preserves dignity while enhancing technical precision.

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SMC: Southeast Asia's First Tattoo-less Site

SEA'S FIRST

TATTOO-LESS CLINICAL SITE

Sunway Medical Centre stands as the **first full SGRT tattoo-less implementation site** in Malaysia and Southeast Asia.

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SMC: Tattoo to Tattoo-less

Oct 2016

Phase 1: Learning phase

Treating **all** cases using tattoo system.

End of 2017

Phase 2: Hybrid workflow

Start with DIBH Breast cases.

Align with tattoo then fine-tune with SGRT

2018

Phase 2: Hybrid workflow

Start using SGRT for other chest and pelvis cases.

Chest - Landmark + SGRT

Pelvis - Tattoo + SGRT

End of 2018

Phase 3: Full Tattoo-less workflow

Completely tattoo-less for all cases

2019 onwards

Phase 4: Workflow Optimization

Improve ROI selection guidelines

Active monitoring workflow etc.

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Workflow Comparison: Conventional vs. SGRT

Conventional Approach

1. **CT Simulation**
   Physical skin markings and permanent tattoos are applied for alignment.
2. **Setup Alignment**
   Daily reliance on lasers and skin marks for initial positioning.
3. **Verification**
   2D EPID or 3D CBCT imaging before treatment delivery.
4. **Subjective Monitoring**
   Intermittent visual checks via CCTV during the treatment fraction.

SGRT Tattoo-less Process

1. **Tattoo-free Simulation**
   No permanent marks required; utilizes natural patient surface anatomy. A 3D reference surface was captured from CT data
2. **Dynamic Guidance**
   Real-time 6DOF surface guidance for rapid & precise daily setup
3. **Verification**
   2D EPID or 3D CBCT imaging before treatment delivery.
4. **Continuous Active Monitoring**
   Intrafraction monitoring with automatic beam-hold for motion safety.

CORE SHIFT Moving from static skin-based markers to dynamic, real-time 3D surface guidance for enhanced safety and dignity.

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BREAST CASE

Retrospective Study

Comparison of two different ROI Shape for Left Breast Cancer with DIBH technique using Surface-Guided Align RT® | Hui Sin Ng, Malissa Sunan

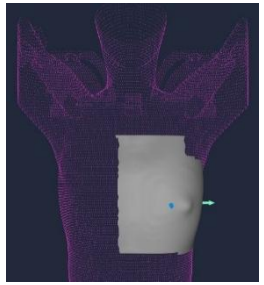
OBJECTIVE

Compare setup accuracy between 2 ROIs

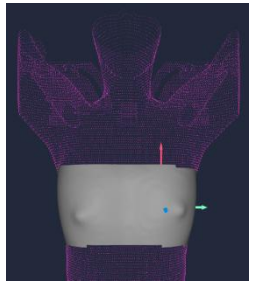
SUBJECTS

5 Left Breast Cancer Patients

ROI 1: Includes Left breast only

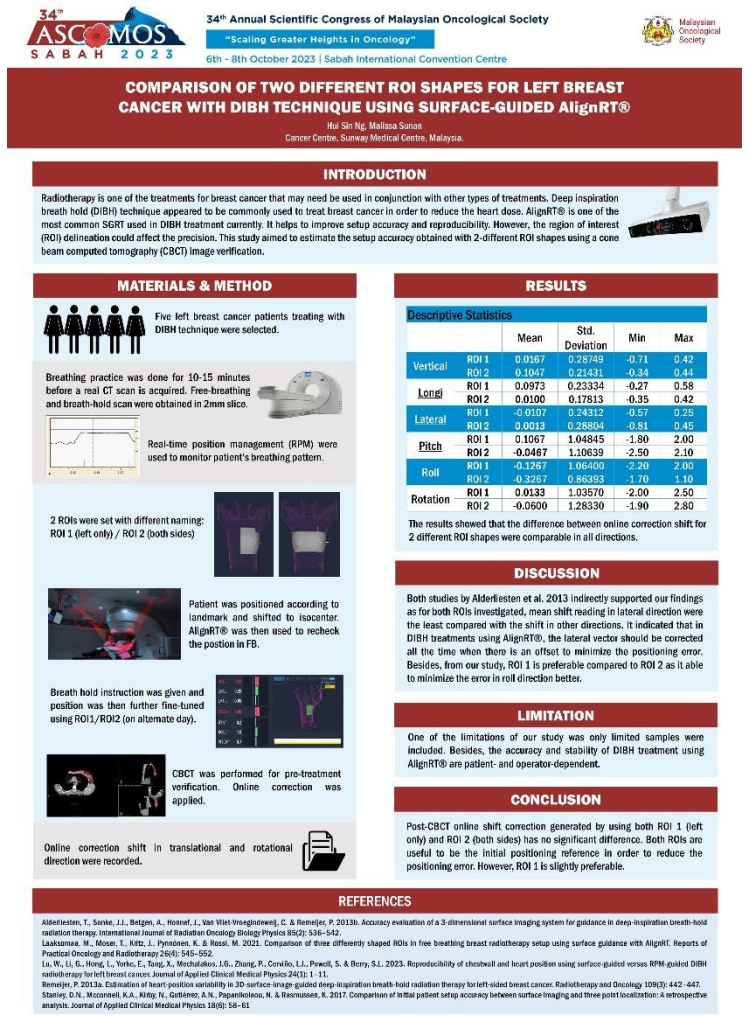


ROI 2: Includes both sides of breast



OUTCOMES

The overall results showed the differences in online correction shifts between the two ROIs were comparable.



34th Annual Scientific Congress of Malaysian Oncological Society
"Scaling Greater Heights in Oncology"
6th - 8th October 2023 | Sabah International Convention Centre

COMPARISON OF TWO DIFFERENT ROI SHAPES FOR LEFT BREAST CANCER WITH DIBH TECHNIQUE USING SURFACE-GUIDED AlignRT®

Hui Sin Ng, Malissa Sunan
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INTRODUCTION

Radiotherapy is one of the treatments for breast cancer that may need be used in conjunction with other types of treatments. Deep inspiration breath hold (DIBH) technique appeared to be commonly used to treat breast cancer in order to reduce the heart dose. AlignRT® is one of the most common SGRT used in DIBH treatment currently. It helps to improve setup accuracy and reproducibility. However, the region of interest (ROI) delineation could affect the precision. This study aimed to estimate the setup accuracy obtained with 2-different ROI shapes using a cone beam computed tomography (CBCT) image verification.

MATERIALS & METHOD

Five left breast cancer patients treating with DIBH technique were selected.

Breathing practice was done for 10-15 minutes before a real CT scan is acquired. Free-breathing and breath-hold scan were obtained in 2mm slice.

Real-time position management (RPM) were used to monitor patient's breathing pattern.

2 ROIs were set with different naming: ROI 1 (left only) / ROI 2 (both sides)

Patient was positioned according to landmark and shifted to isocenter. AlignRT® was then used to recheck the postion in FB.

Breath hold instruction was given and position was then further fine-tuned using ROI1/ROI2 (on alternate day).

CBCT was performed for pre-treatment verification. Online correction was applied.

Online correction shift in translational and rotational direction were recorded.

RESULTS

Descriptive Statistics

		Mean	Std. Deviation	Min	Max
Vertical	ROI 1	0.0167	0.28749	-0.71	0.42
	ROI 2	0.1047	0.21431	-0.34	0.44
Longi	ROI 1	0.0973	0.23334	-0.27	0.58
	ROI 2	0.0100	0.17813	-0.35	0.42
Lateral	ROI 1	-0.0107	0.24312	-0.57	0.25
	ROI 2	0.0013	0.28804	-0.81	0.45
Pitch	ROI 1	0.1067	1.04845	-1.80	2.00
	ROI 2	-0.0467	1.10639	-2.50	2.10
Roll	ROI 1	-0.1267	1.06400	-2.20	2.00
	ROI 2	-0.3267	0.86393	-1.70	1.10
Rotation	ROI 1	0.0133	1.03570	-2.00	2.50
	ROI 2	-0.0600	1.28330	-1.90	2.80

The results showed that the difference between online correction shift for 2 different ROI shapes were comparable in all directions.

DISCUSSION

Both studies by Alderliesten et al. 2013 indirectly supported our findings as for both ROIs investigated, mean shift reading in lateral direction were the least compared with the shift in other directions. It indicated that in DIBH treatments using AlignRT®, the lateral vector should be corrected all the time when there is an offset to minimize the positioning error. Besides, from our study, ROI 1 is preferable compared to ROI 2 as it able to minimize the error in roll direction better.

LIMITATION

One of the limitations of our study was only limited samples were included. Besides, the accuracy and stability of DIBH treatment using AlignRT® are patient- and operator-dependent.

CONCLUSION

Post-CBCT online shift correction generated by using both ROI 1 (left only) and ROI 2 (both sides) has no significant difference. Both ROIs are useful to be the initial positioning reference in order to reduce the positioning error. However, ROI 1 is slightly preferable.

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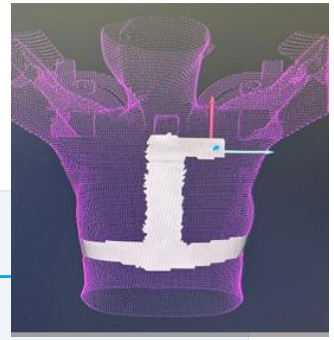
Retrospective Study



From Conventional to Surface-Guided Radiotherapy: A Retrospective Analyzing Changes in Setup Time and Shift Accuracy | Hajarrul Nisha, Kok Hui Sin

OBJECTIVE	COHORT	DATASET
Compare Setup Time & Shift Deviation	60 Breast Cancer Patients	300 dataset collected

Phase 1: Conventional Setup

Standard method utilizing permanent skin tattoos and daily laser alignment.

Phase 2: Early-Phase SGRT

ROI implementation covering the whole chest. Included folded skin areas.

Phase 3: Latest-Phase SGRT

Optimized Protocol Performance

Improved "Inverted T" ROI excluding folds/stomach + "Send to Couch" feature workflow.

OUTCOMES

Maximum Efficiency

Best time efficiency recorded in Phase 3. (ranging from 2-9 mins)

Vertical Accuracy

Superior vertical setup precision

Longitudinal Precision

Comparable with other phases

Validated Superiority for Clinical Performance

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SMC: DIBH Breast Cases

CT SIMULATION

With RGSC, obtain FB and DIBH scans.

BEFORE TREATMENT

Import both FB and DIBH structures
Choose ‘Treat with Beam Control’.

ROI Guidelines

- Include the whole breast/ chest wall of treated site
- Include lower 2/3 of contralateral breast
- Include mid-coronal plane of both sides

SMC: DIBH Breast Cases

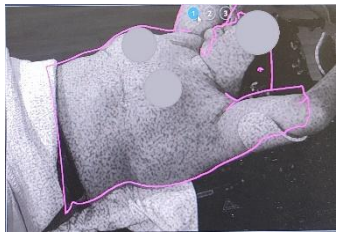
DURING TREATMENT

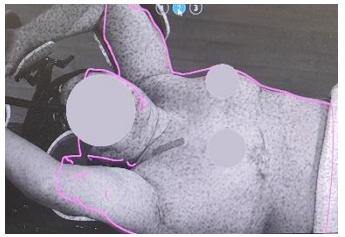
First day: Landmark >> isocenter
Other day: Shift to Isocenter

With FB reference structure,
Fine tune the position
Perform ‘Send to couch’.

Arm and head adjustment with postural module.
Perform ‘Send to couch’ again when needed.

Change to DIBH structure.
Perform breath hold instruction with VCD as guide.
Perform ‘Send to Couch’ and **untick vertical**.



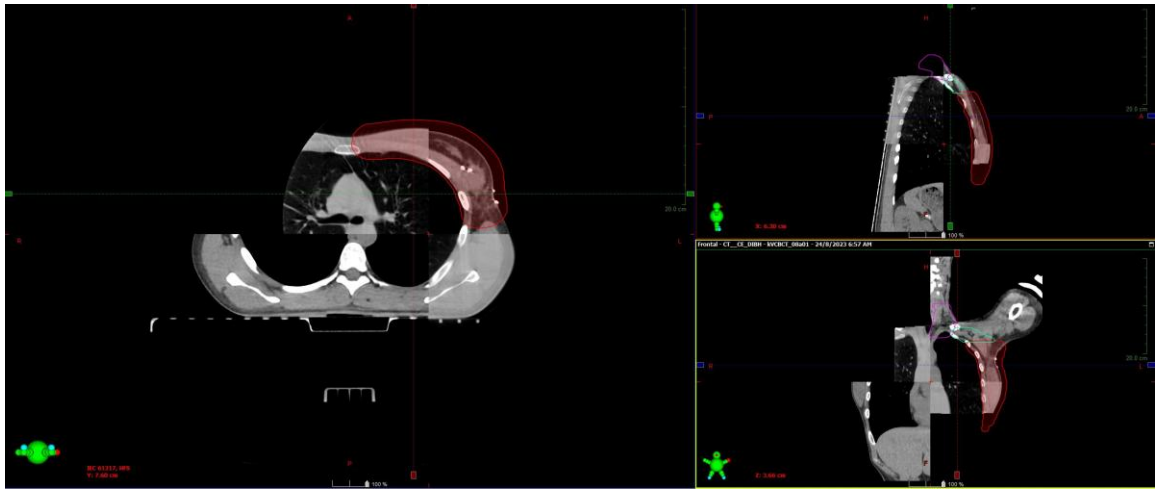


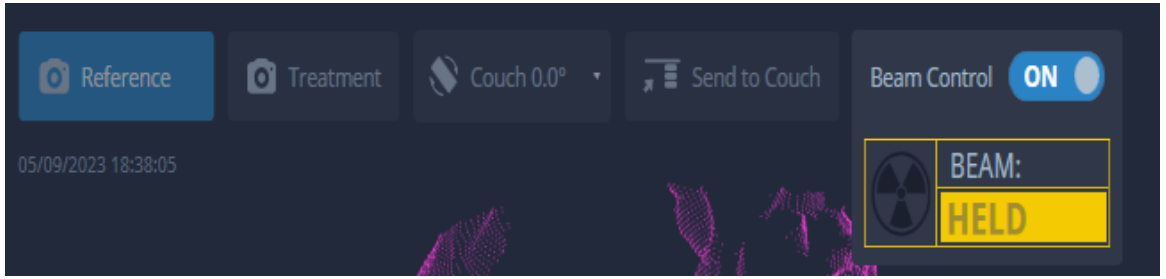
SMC: DIBH Breast Cases

DURING TREATMENT – CONT

Continue with treatment verification
Capture a new reference with breath-hold after couch shift.

Switch on ‘Beam control’ for gated treatment.





Challenges in treating Breast case

1. **Breast Swelling/ Skin Folds**
   Changes in breast surface contour during treatment may cause larger SGRT deviations despite correct internal anatomy.

2. **Weight loss / Seroma**
   Seroma volume can decrease over the course of treatment. Reduction in body contour affects surface matching accuracy

3. **Arm position reproducibility**
   Inconsistent arm elevation or shoulder rotation changes breast position and chest wall geometry

4. **Breath hold reproducibility**
   Variability in breath-hold depth or duration affects heart displacement and target position

Challenges in treating Breast case

1

Breast Swelling/ Skin Folds

Changes in breast surface contour during treatment may cause larger SGRT deviations despite correct internal anatomy.

SGRT deformation tool / recapture a new reference after image verification.
Careful ROI selection.

2

Weight loss / Seroma

Seroma volume can decrease over the course of treatment. Reduction in body contour affects surface matching accuracy

SGRT deformation tool / recapture a new reference after image verification.

3

Arm position reproducibility

Inconsistent arm elevation or shoulder rotation changes breast position and chest wall geometry

SGRT postural module/ treatment capture function.

4

Breath hold reproducibility

Variability in breath-hold depth or duration affects heart displacement and target position

SGRT Video couching device/ Active monitoring with threshold.

Clinical Workflow Advantages

The integration of SGRT optimizes the radiotherapy department's work flow from simulation to daily treatment delivery.

EFFICIENCY

Rapid Setup

Send-to-Couch:
Enables automated couch shift to fine tune patient setup.

Reduces manual labor and speeds up the initial alignment phase.

PRECISION

Minimal Rework

Reduced Repositioning:
Ensure more accurate first-time patient setup minimizes re-adjustments.

Fewer repeat imaging sessions required to verify positioning.

RELIABILITY

Daily Consistency

Setup Reproducibility:
Ensures consistent treatment quality across all fractions as new reference images can be taken for future use when needed.

Reduces variability between different RTTs.

SAFETY

Active Monitoring

Intrafraction Tracking:
Real-time tracking. Able to detect sudden drift/motion.

Automatic beam-hold features provide another layer of safety.

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Challenges Faced During Implementation

Initial Learning Curve

Familiarization with SGRT equipment and control console.

Region of Interest (ROI) selection & management.

Selection of suitable surface landmarks as reference.

Workflow Redesign

Revise traditional clinical routines to integrate SGRT checks.

Continuous research and observation to optimize daily performance.

Staff Training & Adaptation

Intensive physical trainings and online courses for RTTs, Physicists

Resource Considerations

Balancing equipment costs with long-term clinical efficiency.

Overcoming these hurdles required a multidisciplinary approach, combining technical training with a commitment to patient-centered innovation.

Lesson Learned

1. Clear guideline and workflow and review regularly
2. Train therapists before clinical go-live
3. Start with breast cases
4. CBCT as verification

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Take Home Message

- Successful implementation on Varian TrueBeam has been achieved for not only for breast cases but also other treatment sites.
- Optimized ROI selection and workflow significantly improved efficiency and setup reproducibility.
- SGRT complements CBCT by providing continuous real-time monitoring throughout treatment.
- Tattoo-less radiotherapy enhances precision while improving patient comfort, dignity, and overall treatment experience.

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THANK YOU

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