Enhancing Setup Accuracy and Minimizing Margins with an Optical Surface Imaging System (Align RT) for Pelvic Cancers- KSSSCI Experience

Dr. Pramod Kumar Gupta
MD(SGPGI), DNB, AROI Fellow(MSKCC, USA)
Associate Professor of Radiation Oncology
Kalyan Singh Super Speciality Cancer Institute
Lucknow, Uttar Pradesh

Need for using SGRT in Pelvic radiotherapy

- Accuracy and reproducibility of the patient's position are fundamental to the successful delivery of radiation therapy.

- The patient setup in routine radiotherapy is usually performed by alignment of in-room lasers with patient skin marks or with thermoplastic cast/ mask and the verification of the patient setup by cone-beam computed tomography (CBCT).

- Daily imaging usually performed to achieve optimal patient positioning accuracy with minimal setup margins.

Need for using SGRT in Pelvic radiotherapy

- However, daily online verification using imaging increases the dose to normal tissue and the overall treatment time resulting in a lower number of patients that can be treated per day.

- A lower frequency of online verifications requires larger setup margins to compensate for the inter-fractional patient setup error, and larger target volumes - increase in the risk of radiation toxicity.

- A possible strategy to reduce the number of CBCTs while maintaining sufficient patient positioning accuracy, could be the use of SGRT.

Need for using SGRT in Pelvic RT

- SGRT - less immobilization devices which makes it comfortable for patient and easy setup for technologists.
  - No long masks - Less Expensive

- SGRT allows us to eliminate tattoos and skin marks for most of our patients.

- Improve safety for all patient cohort through monitoring and automated beam hold and increased information about the patient position during RT delivery

- SGRT has the potential to greatly impact the quality and safety of radiation treatments.

Recent Literature on SGRT for Pelvic RT

www.nature.com/scientificreports

scientific reports

OPEN

Setup accuracy and margins for surface-guided radiotherapy (SGRT) of head, thorax, abdomen, and pelvic target volumes

Volker Rudat✉, Yanyan Shi, Ruping Zhao, Shuyin Xu & Wei Yu

Scientific Reports | (2023) 13:17018 | https://doi.org/10.1038/s41598-023-44320-2 nature portfolio

SGRT opens the possibility to reduce the number of CBCTs while maintaining sufficient setup accuracy. The advantage is a reduction of imaging dose and overall treatment time

Received: 5 June 2017 | Revised: 20 July 2017 | Accepted: 27 July 2017

DOI: 10.1002/acm2.12183

RADIATION ONCOLOGY PHYSICS

WILEY

Comparison of initial patient setup accuracy between surface imaging and three point localization: A retrospective analysis

Dennis N. Stanley[1] | Kristen A. McConnell[1] | Neil Kirby[1] | Alonso N. Gutiérrez[1,2] | Nikos Papanikolaou[1] | Karl Rasmussen[1]

Surface imaging systems can be considered a viable option for initial patient setup and may be preferable to permanent marks for specific clinics and patients.

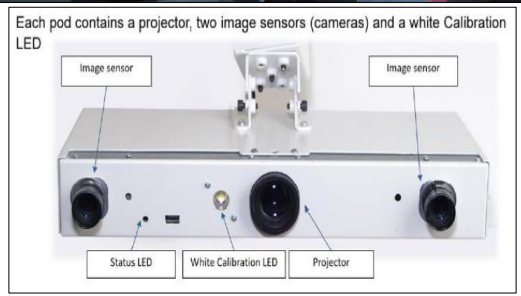
BASIC OVERVIEW OF SGRT

❖ **Setup**

- Three ceiling mounted camera pods (~90ºapart)
- One central and two lateral pods

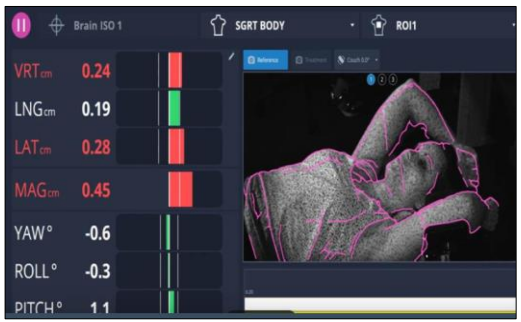
❖ **Surface Reconstruction:**

- Each pod contains two camera sensors and a projector enabling real time 3D surface reconstruction



❖ **Registration**

- The live surface is registered to a reference surface generating 6DOF shift information (real time deltas)
- Frame rates up to 25 fps with AlignRT v6.0



❖ **Patient biofeedback**

- Visual (Real-time coach)

Courtesy: Dennis N. Stanley, Ph.D., The University of Alabama at Birmingham

GO LIVE: 1st April 2022

SGRT Community
@SGRTCommunity

Congratulations to the team at Kalyan Singh Super Speciality Cancer Institute in Lucknow who have just gone live with AlignRT.

The Institute is the fifth center in India and the first center in Uttar Pradesh to adopt AlignRT SGRT technology.

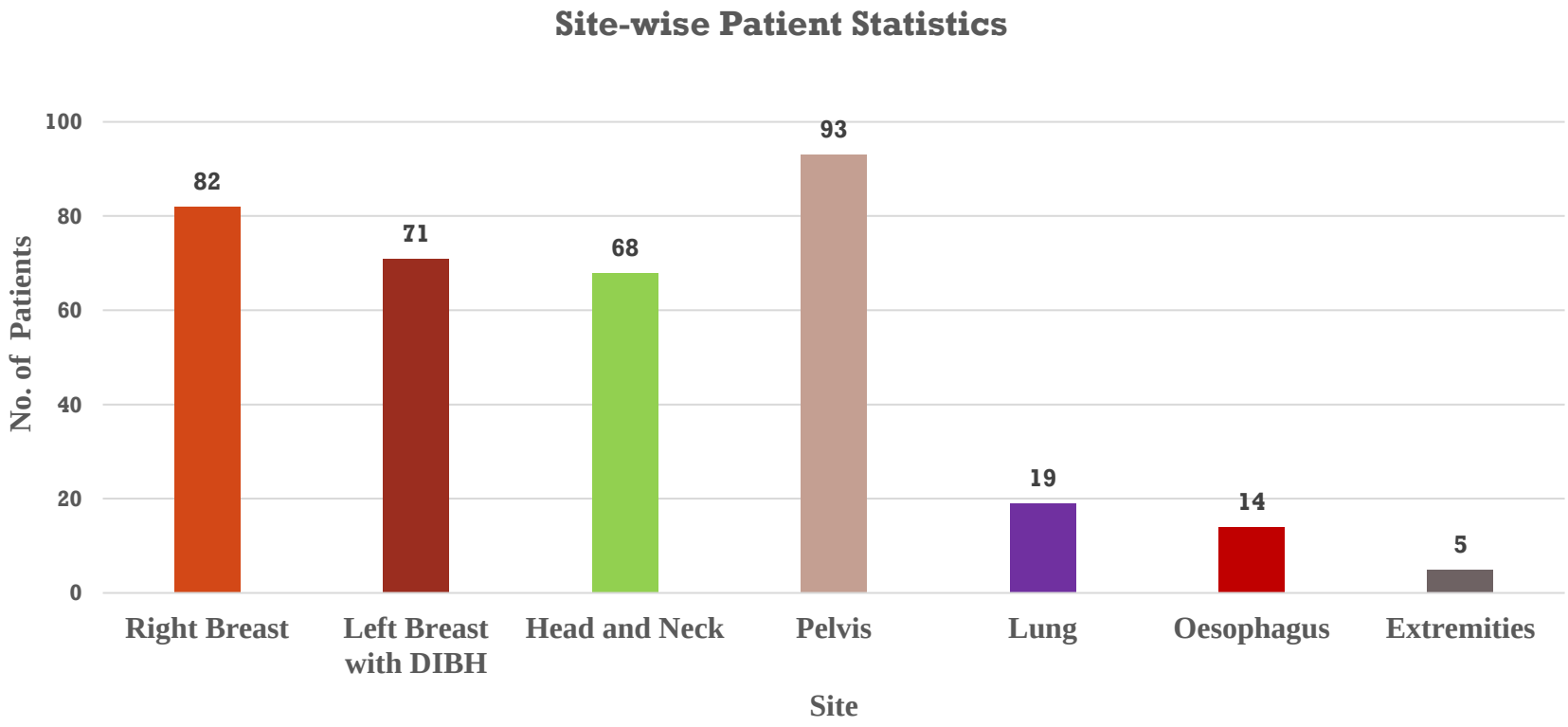
SGRT:Entry to a new era of precision radiation therapy

- We are treating the following sites using Surface Guided Radiation Therapy(SGRT):

  - Right Breast
  - Left Breast with DIBH
  - Open Face Head and Neck
  - Lung
  - Oesophagus
  - Pelvis malignancies
  - Extremities

Experience with SGRT - KSSSCI

(n=350+)



KSSSCI Experience - Surface Guided Radiotherapy in patients undergoing RT for Pelvic malignancies

Purpose

- This study aims to compare the setup accuracy and set up margin in patients with pelvic cancers positioned with either a maskless SGRT setup or a thermoplastic mask-based laser setup.

Our SGRT system (Align RT v6.3) Overview

❖ **Two Linear Accelerators**

- LA-I (Varian TrueBeam) + 6DoF+ AlignRT (Vision RT)

LA-I

❖ **4DCT Simulator**

- Philips Big Bore RT+ SimRT (Vision RT)

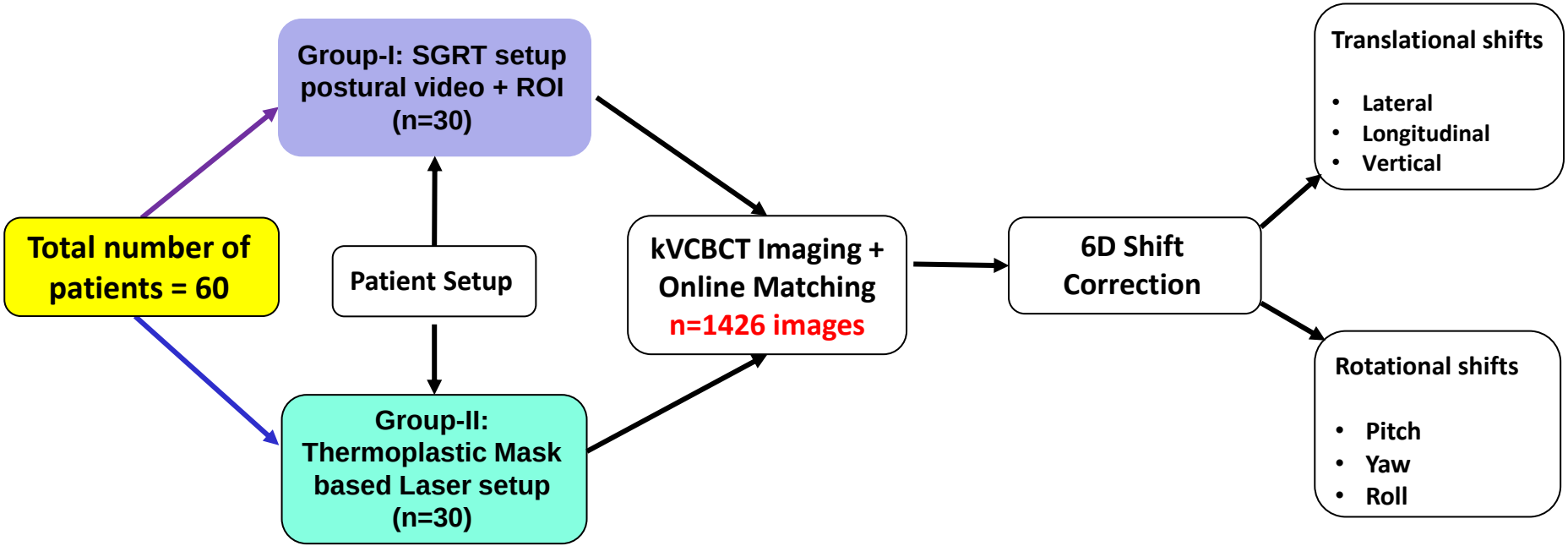
Material and Methods

- In a prospective observational study, from May 2022-May 2023, patients with pelvic cancers (Cervix, Endometrium, Rectum, Anal canal) undergoing RT were included.

- A total of 1426 RT fractions of 60 consecutive patients were analyzed.

- All patients received daily kV-CBCT for online verification in a TrueBeam SVC unit with a six-dimensional IGRT couch and the SGRT system AlignRT.

Study design



PTV margin calculation

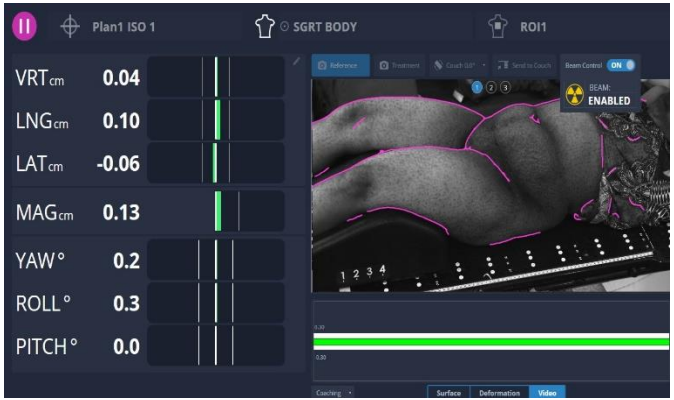
- The corresponding PTV margins were calculated using the van Herk formula

- Mann–Whitney U and ANOVA tests were done for comparison

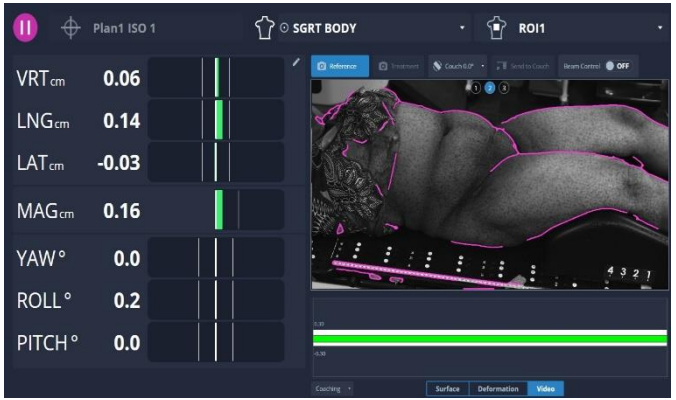
SGRT – Drawing of ROI

Figure shows the anterior and lateral view of ROI drawn in a pelvic patient.

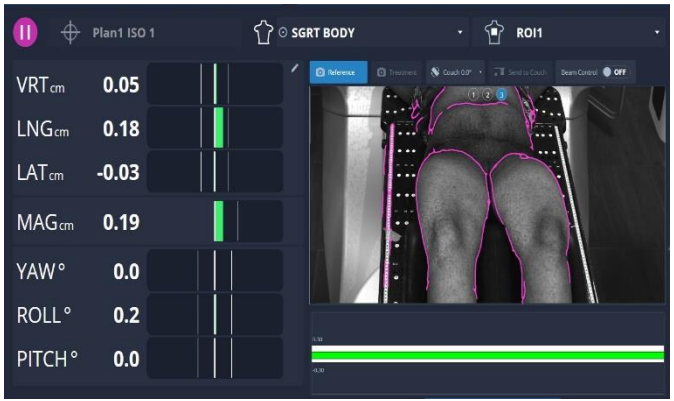
Patient Setup using Postural Video



Camera Pod 1

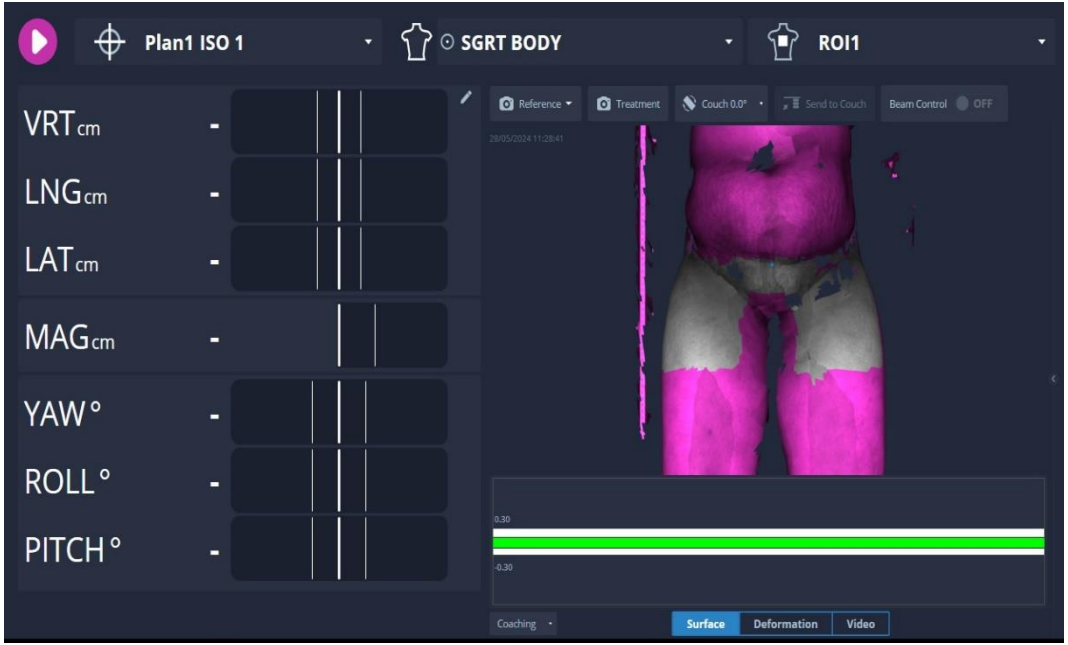


Camera Pod 2

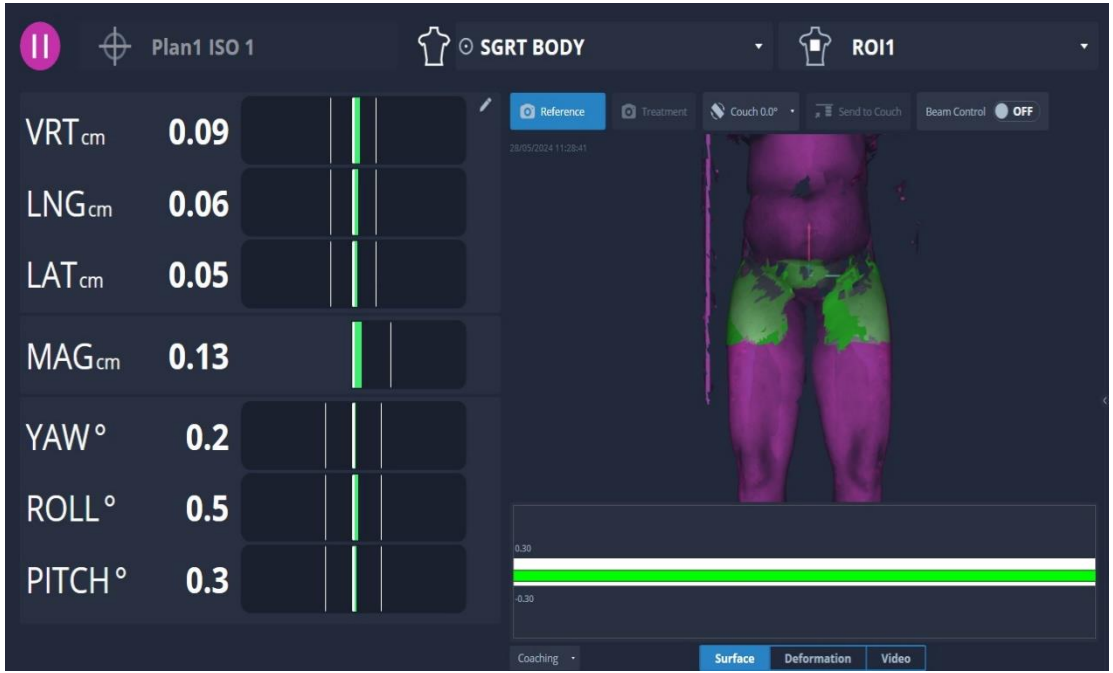


Camera Pod 3

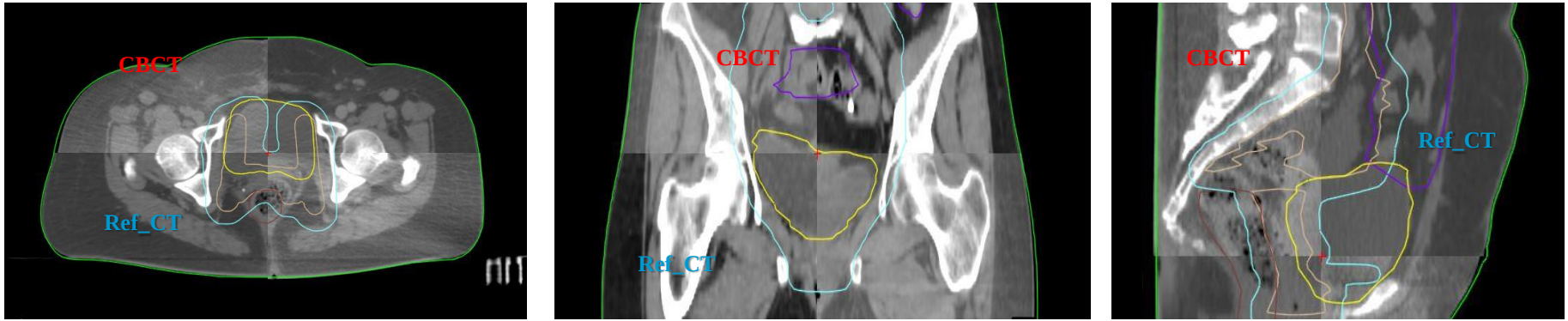
Patient Setup using ROI



Real time monitoring of patient using SGRT



KV-CBCT Imaging & Matching



Split window view matching of cone beam computed tomography (CBCT) vs. Reference CT image

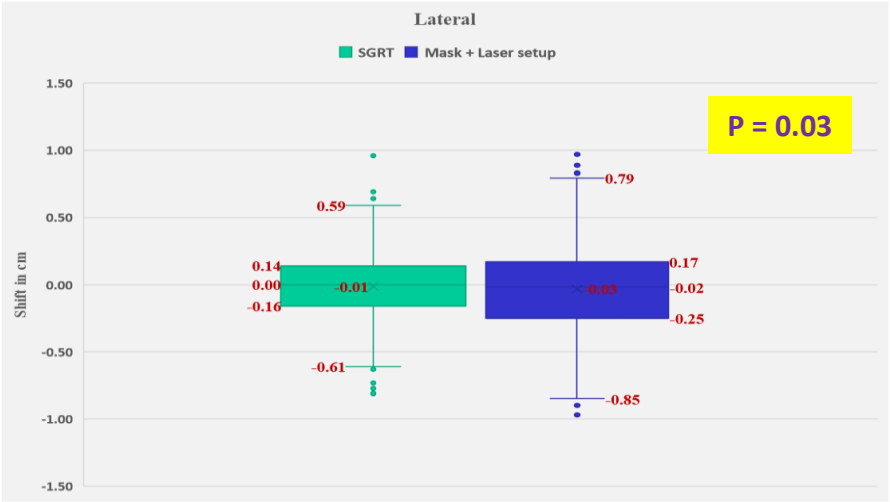
Results

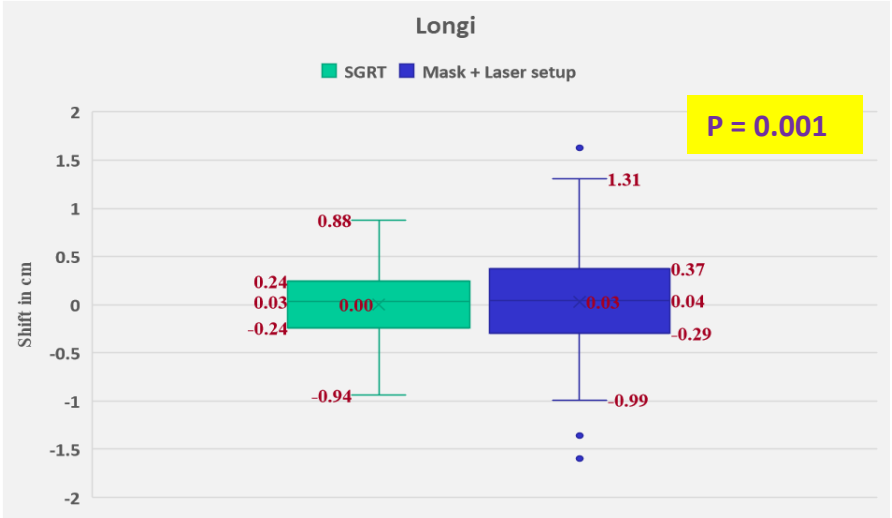
- **Lateral** (1.95mm±0.67 vs. 2.70mm±1.46, p=0.03) and **longitudinal** (2.90mm±0.82 vs. 3.74mm±1.10, p=0.001) shifts were significantly reduced with SGRT setup.

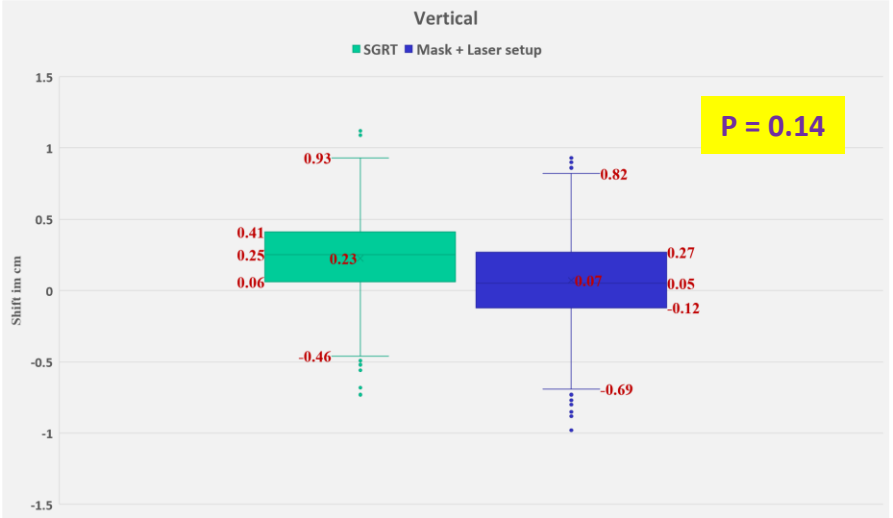
- However, the vertical and rotational shifts showed comparable variation in both groups (p=0.14).

- The mean three-dimensional vector of the translational setup deviation for the group-I was (**1.91mm**±0.36) (95%CI, 1.78-2.04mm), while in the group-II, it was (**2.26mm**±0.48) (95% CI,2.09-2.43 mm) (p <0.05).

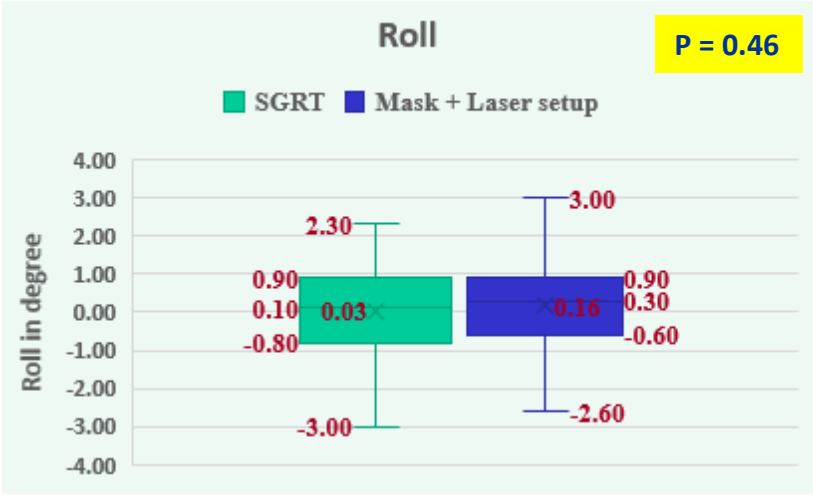
Translational Shifts

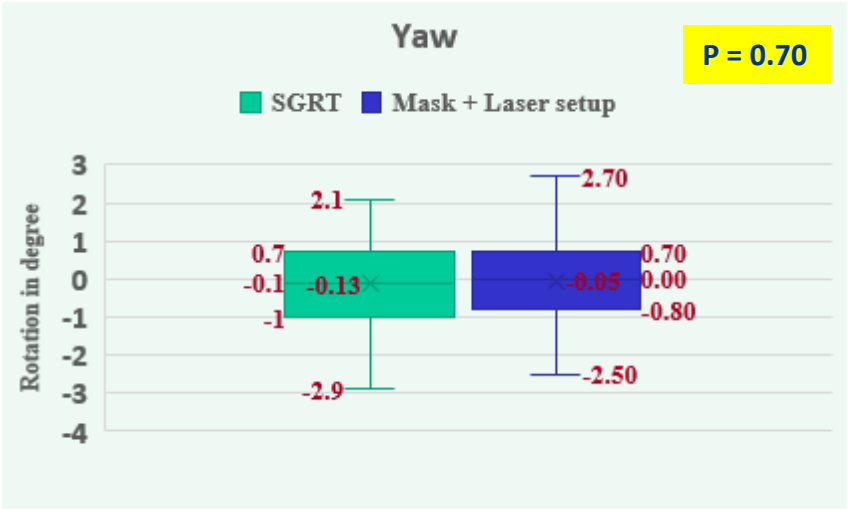


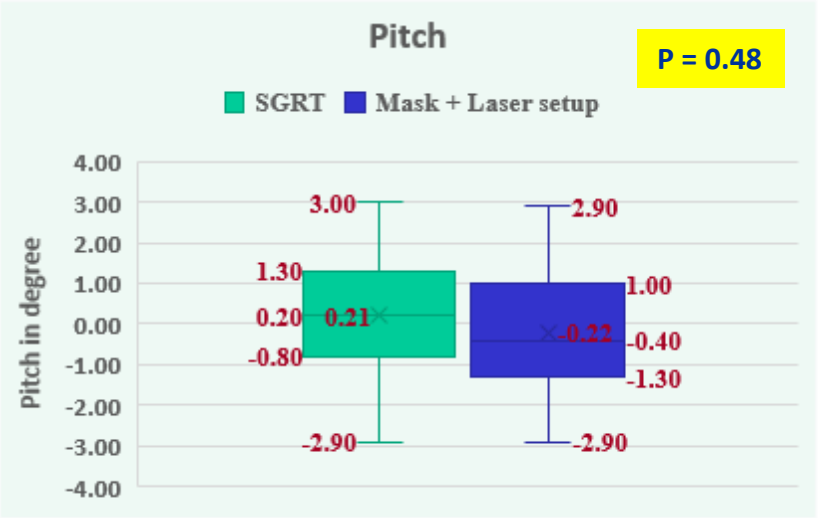




Rotational Shifts



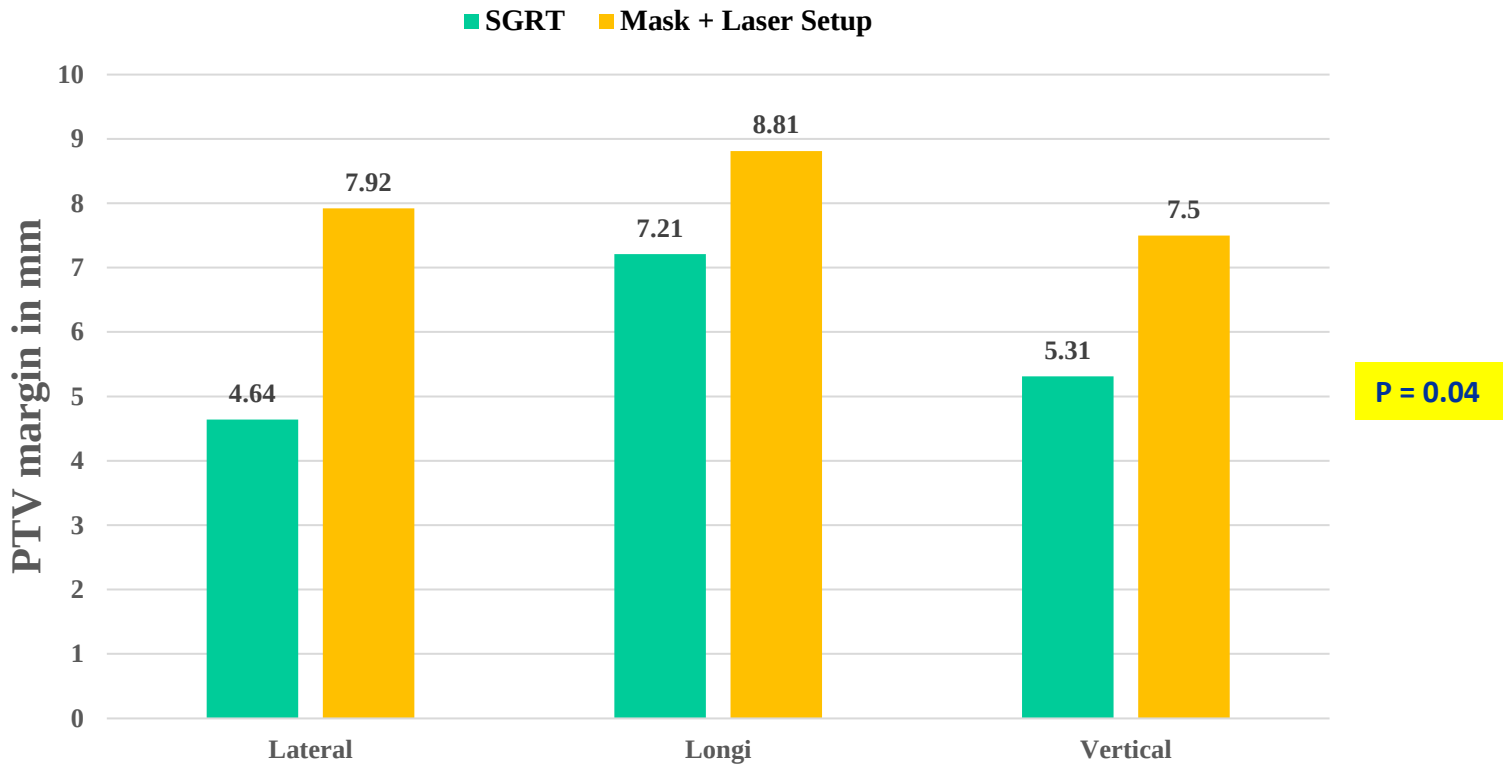




Systematic and Random Error calculation

Shifts	SGRT		Mask + Laser Setup	
	Systematic Error (∑)	Random Error (σ)	Systematic Error (∑)	Random Error(σ)
	(mm)		(mm)	
Lateral	1.22	2.27	2.37	2.60
Longitudinal	2.01	3.11	2.37	4.11
Vertical	1.43	2.46	2.37	2.18

Result - Calculated PTV margins



Challenges with SGRT setups

- RT Therapists have issues working with big obese patients with too much skin folds.
  - learning curve for proper selection of ROI

- Poor correlation of surface to internal motion can be a limiting factor

Conclusions

- The study demonstrated improvement in patient setup with SGRT Align RT with a reduction in PTV margins compared to masks with laser setup.

- Reduction in margin would result in the lesser dose to organs at risk therefore lowering normal tissue toxicity and ensuring high precision in inter and intra-fraction RT delivery.

- Patients with pelvic malignancies can undergo daily SGRT-based setup for accurate and reproducible patient positioning without frequent additional imaging and lesser overall treatment time.

References

1. Mannerberg A, Kügele M, Hamid S, Edvardsson A, Petersson K, Gunnlaugsson A, et al. Faster and more accurate patient positioning with surface guided radiotherapy for ultra-hypofractionated prostate cancer patients. Tech Innov Patient Support Radiat Oncol. 2021;19(June):41–5.

2. Carl G, Reitz D, Schönecker S, Pazos M, Freislederer P, Reiner M, et al. Optical surface scanning for patient positioning in radiation therapy: A prospective analysis of 1902 fractions. Technol Cancer Res Treat. 2018;17:1–9.

3. Walter F, Freislederer P, Belka C, Heinz C, Söhn M, Roeder F. Evaluation of daily patient positioning for radiotherapy with a commercial 3D surface-imaging system (Catalyst™). Radiat Oncol [Internet]. 2016;11(1):1–8.

4. Mannerberg A, Kügele M, Hamid S, Edvardsson A, Petersson K, Gunnlaugsson A, et al. Faster and more accurate patient positioning with surface guided radiotherapy for ultra-hypofractionated prostate cancer patients. Tech Innov Patient Support Radiat Oncol. 2021;19(June):41–5.

5. Stanley DN, Mcconnell KA, Kirby N, Gutiérrez AN, Papanikolaou N, Rasmussen K. Comparison of initial patient setup accuracy between surface imaging and three point localization: A retrospective analysis. J Appl Clin Med Phys. 2017;18(6):58–61.

6. Qubala A, Schwahofer A, Jersemann S, Eskandarian S, Harrabi S, Naumann P, et al. Optimizing the Patient Positioning Workflow of Patients with Pelvis, Limb, and Chest/Spine Tumors at an Ion-Beam Gantry based on Optical Surface Guidance. Adv Radiat Oncol. 2023;8(2).

7. Batista V, Gober M, Moura F, Webster A, Oellers M, Ramtohul M, et al. Surface guided radiation therapy: An international survey on current clinical practice. Tech Innov Patient Support Radiat Oncol. 2022;22(November 2021):1–8.

Acknowledgement

- Dr. Sharad Singh, Dr. Rumita Singh - Faculty
- Medical Physicist (Scientist-1) – Mr. Sumanta M, Mr. Ragul T
- All Senior residents, Junior Residents
- All Medical physics residents
- All Radiotherapy technologists
- All Supportive and nursing staff

THANK YOU