Enhancing the Positioning Accuracy of Pelvic Irradiation in Prone Position with Surface-Guided RadioTherapy

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KU:P

Outline

- Introduction of Kyoto university hospital
- SGRT for pelvic irradiation in prone position
  - Improvement of positioning accuracy
  - Determine the intrafractional motion
  - Our recommended setup procedure using AlignRT

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Department of Radiation Oncology

- 953 new patients/year (2022)
  - IMRT: 361
  - Brain SRT: 139
  - SBRT: 132
- Staff in radiation oncology
  - 12 radiation oncologists
  - 5 medical physicists
  - 18 radiology technologists

External radiotherapy in KUHP

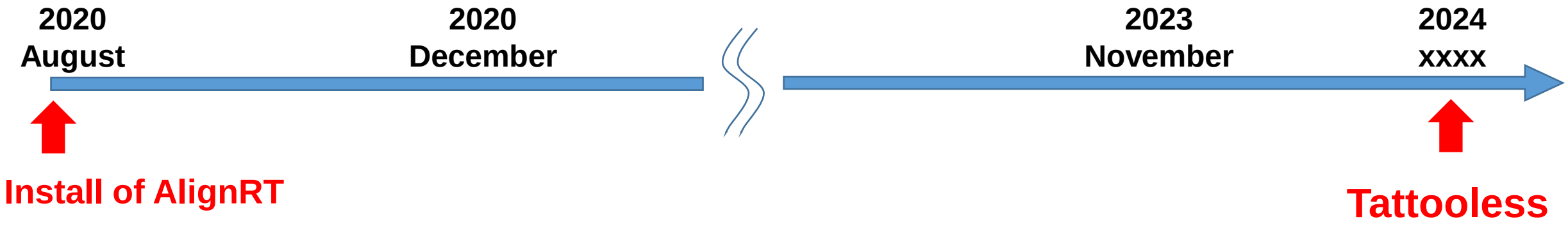
	Vero4DRT (OXRAY)	TrueBeamSTx	TrueBeam	TrueBeam	Ethos
					
Treatment	Prostate VMAT Lang SBRT Liver SBRT Dynamic tracking	Brain SRT/SRS Spine SBRT	Rt. Breast Whole brain Eso. IMRT	Lt. breast DIBH Pelvis Extremity HyperArc	Head and neck Lung, Pancreas Adaptive RT
SGRT	**-**	**-**	**-**	**AlignRT**	**-**

SGRT in Kyoto university hospital

Breast, HyperArc (for only monitoring in irradiation)

Pelvic treatment in prone position with bellyboard

Almost treatment



Breast : setup without IGRT (with MV cine image)

Other sites : setup with IGRT after

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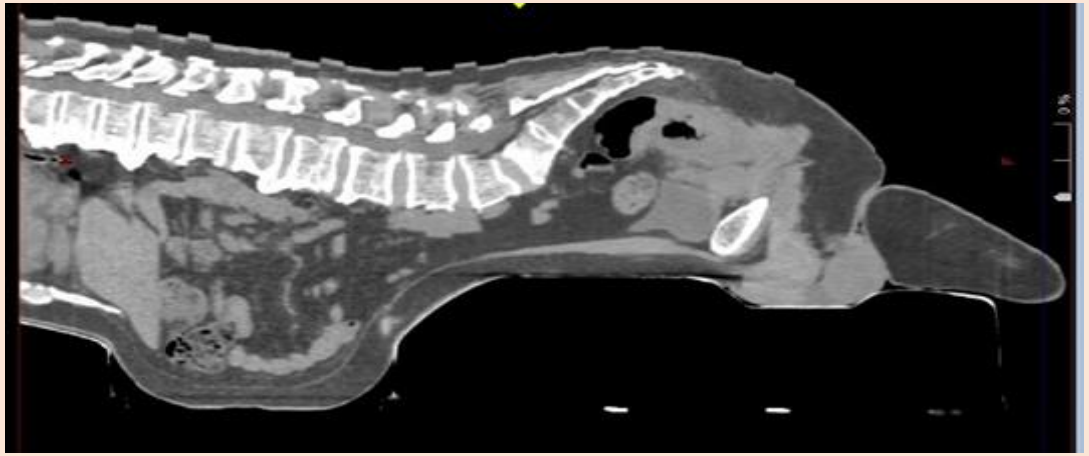
Prone position for pelvic treatment

Advantage

Dose reduction to small bowels by using belly board device



Disadvantage

1. Low positioning accuracy

Orientation	Pitch error (deg)	Yaw error (deg)	Roll error (deg)
Prone	1.97 ± 1.28	0.57 ± 0.49	1.04 ± 0.94
Supine	0.80 ± 1.08	0.46 ± 0.59	0.35 ± 0.53
p value	<0.001	0.35	<0.001

2. Uncomfortable for patient

Intrafractional motion is a concern

A. Kim, et al. *Radiat.Oncol*.2017

Objectives

Determine the **effectiveness of a surface-guided radiotherapy (SGRT) system in prone pelvic irradiation** using a belly board device.

- Clarify whether or not **AlignRT improves positioning accuracy** compared to laser and skin marker-based positioning
- **Determine the intrafractional motion** by monitoring the surface displacement during irradiation with AlignRT

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Patient setup and positioning accuracy

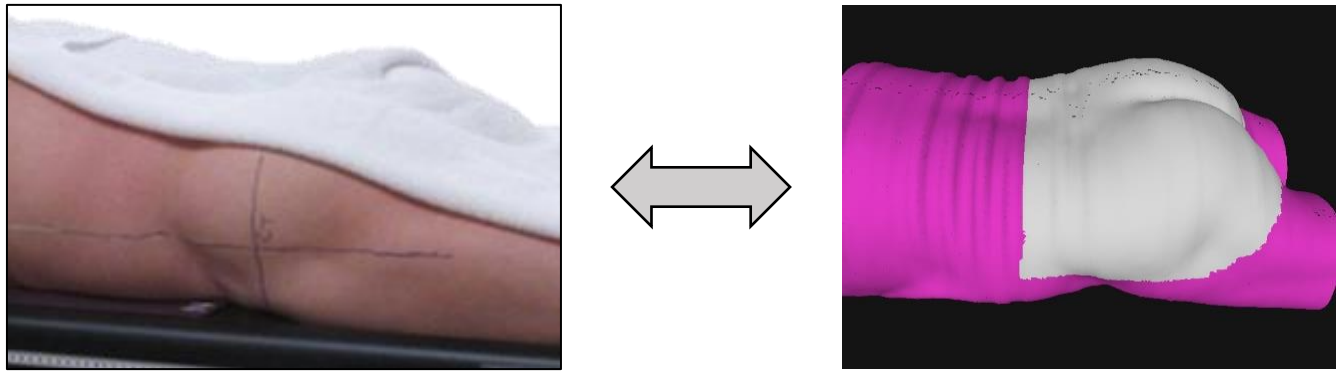
Laser and skin mark-based setup (L) group

Setup with **laser and skin marker** → CBCT

SGRT-based setup (S) group

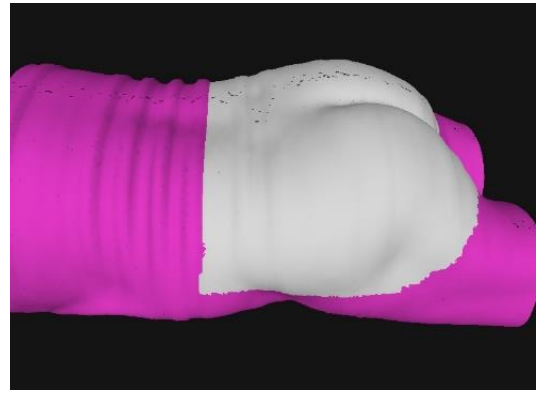
Setup with **AlignRT** → CBCT

Interfractional setup error was calculated from **3D/3D bony anatomy matching** using CBCT, and **compared between two groups**

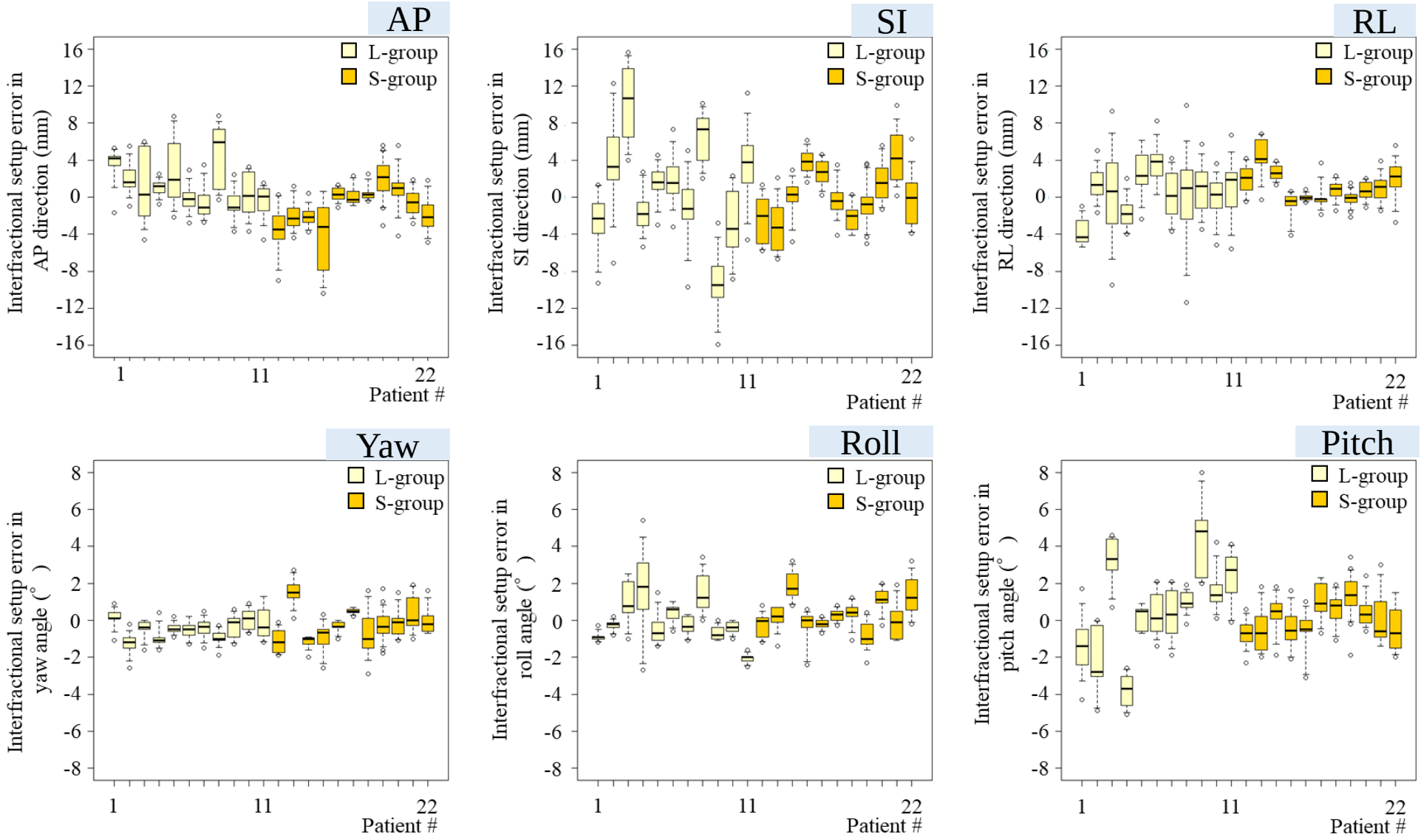


Cases and Materials

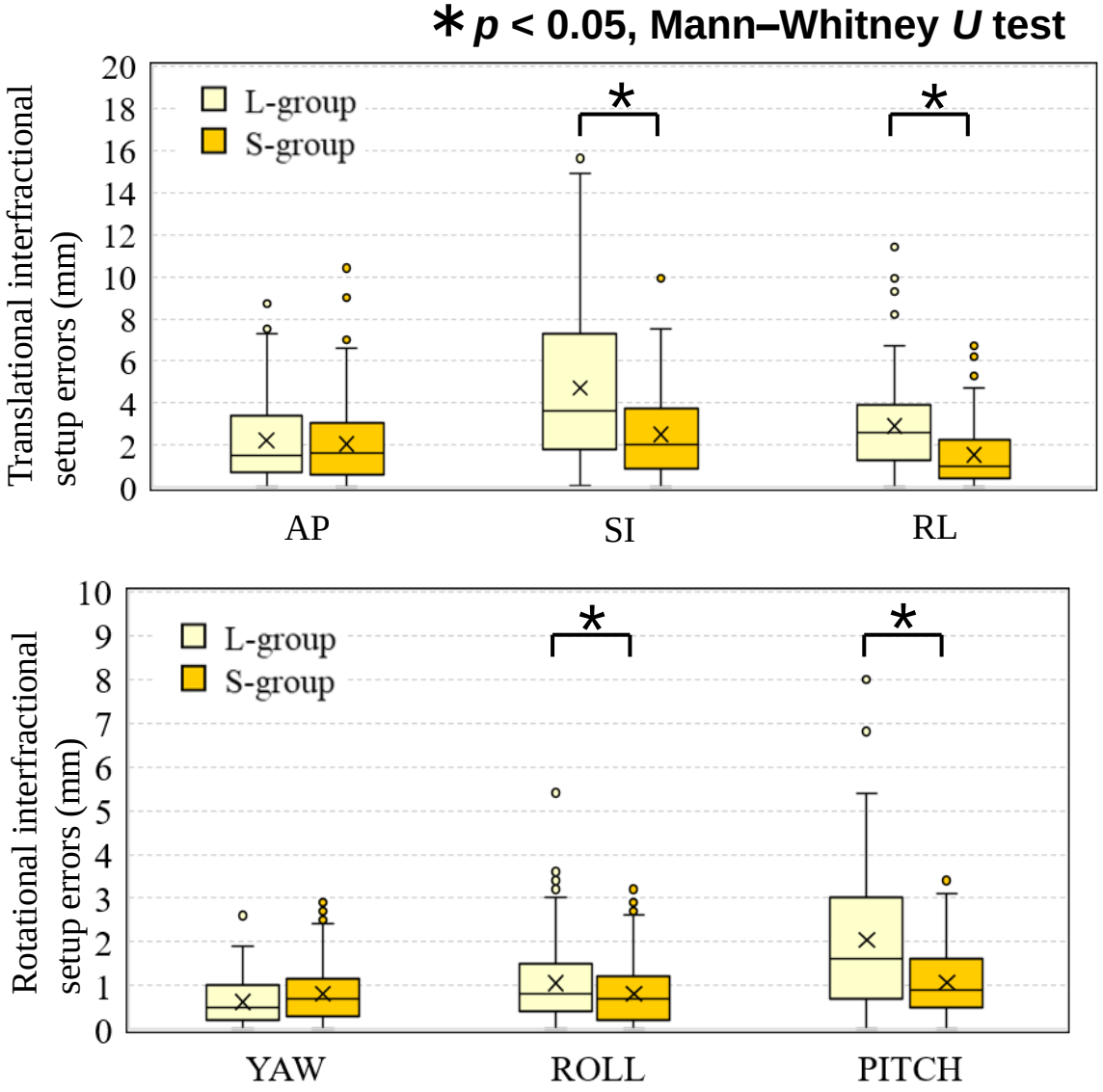
	Laser (L) group	SGRT (S) group
Cases: Male/Female	11 (6/5)	11 (10/1)
Age：Median [Range]	55 [41 - 78]	71 [56 - 82]
Site（Rectum/Anal canal）	9/2	10/1
Linac	Clinac iX (Varian)	TrueBeam (Varian)
Setup method	Laser and skin mark	AlignRT (Vision RT)
Immobilization	belly board (CIVCO)	



Interfractional setup error



Summery of interfractional setup error



- Positioning accuracy was significantly improved in the SI, RL, direction, and roll and pitch angles.
- Improvement in SI direction and pitch angle was remarkable
- Setup error exceed 3° in pitch angle;
  - 20.7% of fractions in L group
  - 0.7% of fractions in S group

Comparison with previous report ~Prone position~

	Interfractional setup error (mm, °)*					
	AP	**SI**	**RL**	**YAW**	**ROLL**	**PITCH**
A Kim et al. 2017 [1)] **With Laser**, n = 8	-	-	-	0.6 ± 0.5	**1.0 ± 0.9**	**2.0 ± 1.3**
AS Allal et al.2002 [2)] **With Laser**, n = 9	**4.5 ± 4.2**	**4.2 ± 5.3**	**3.2 ± 3.9**	-	-	-
Our study **With SGRT, n = 11**	**2.1 ± 1.9**	**2.5 ± 2.0**	**1.5 ± 1.5**	0.8 ± 0.6	**0.8 ± 0.7**	**1.1 ± 0.7**

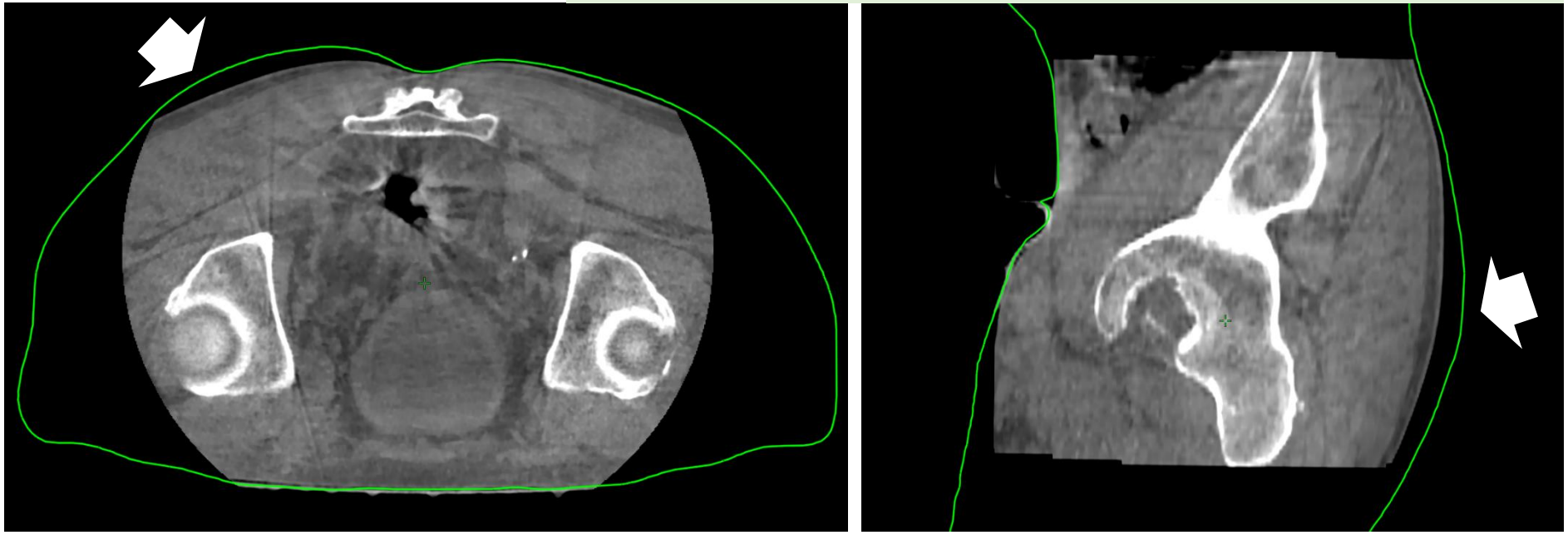
*** Mean ± Standard deviation**

Compared with previous reports, **SGRT-based setup improves positioning accuracy**

Factor that cause the positioning inaccuracy

- **Alterations in the muscular tone of the gluteal muscles** from CT simulation

Green line：Body contour in simulating CT



Setup error : ROLL 2.7°, PITCH 1.8°

Shame due to skin exposure affects the muscular tone?

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Determine the intrafractional motion

SGRT-based setup (S) group

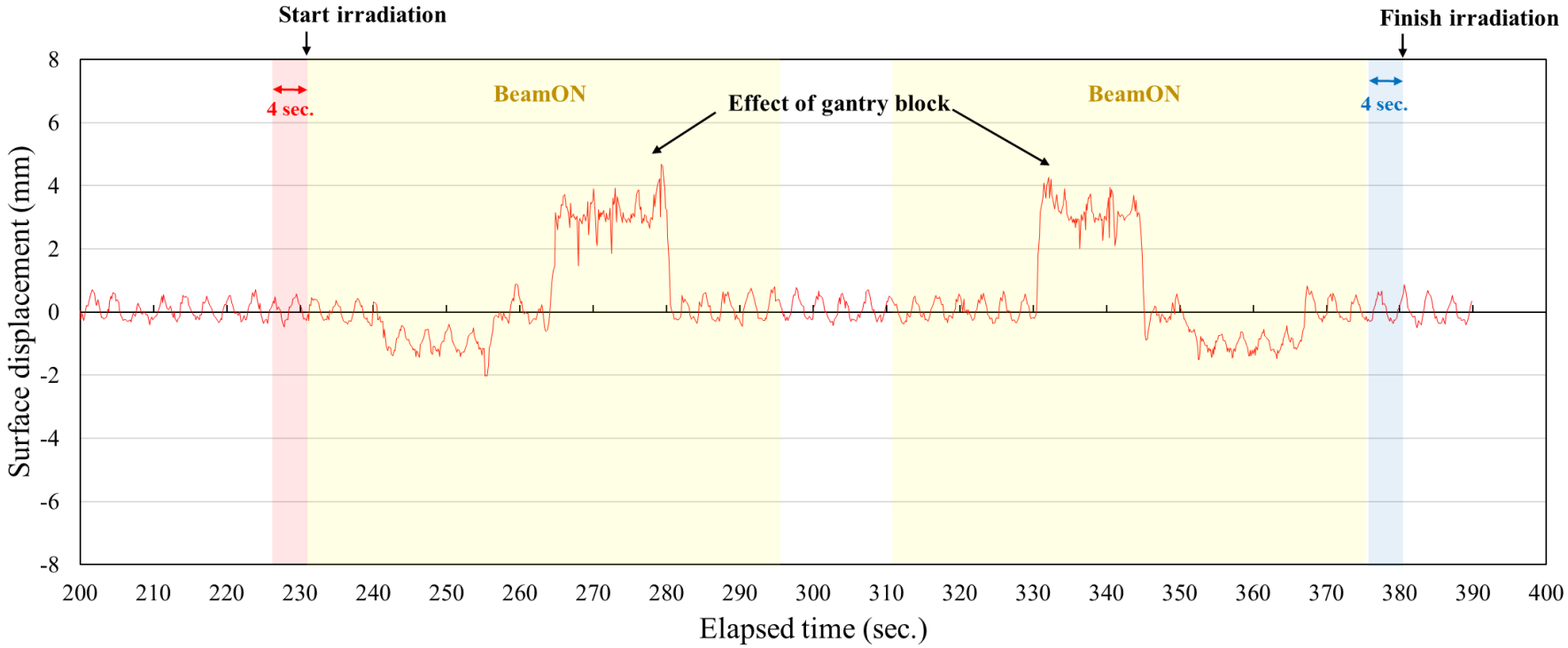
Setup with AlignRT → CBCT → **irradiation**

Monitoring the surface position during irradiation

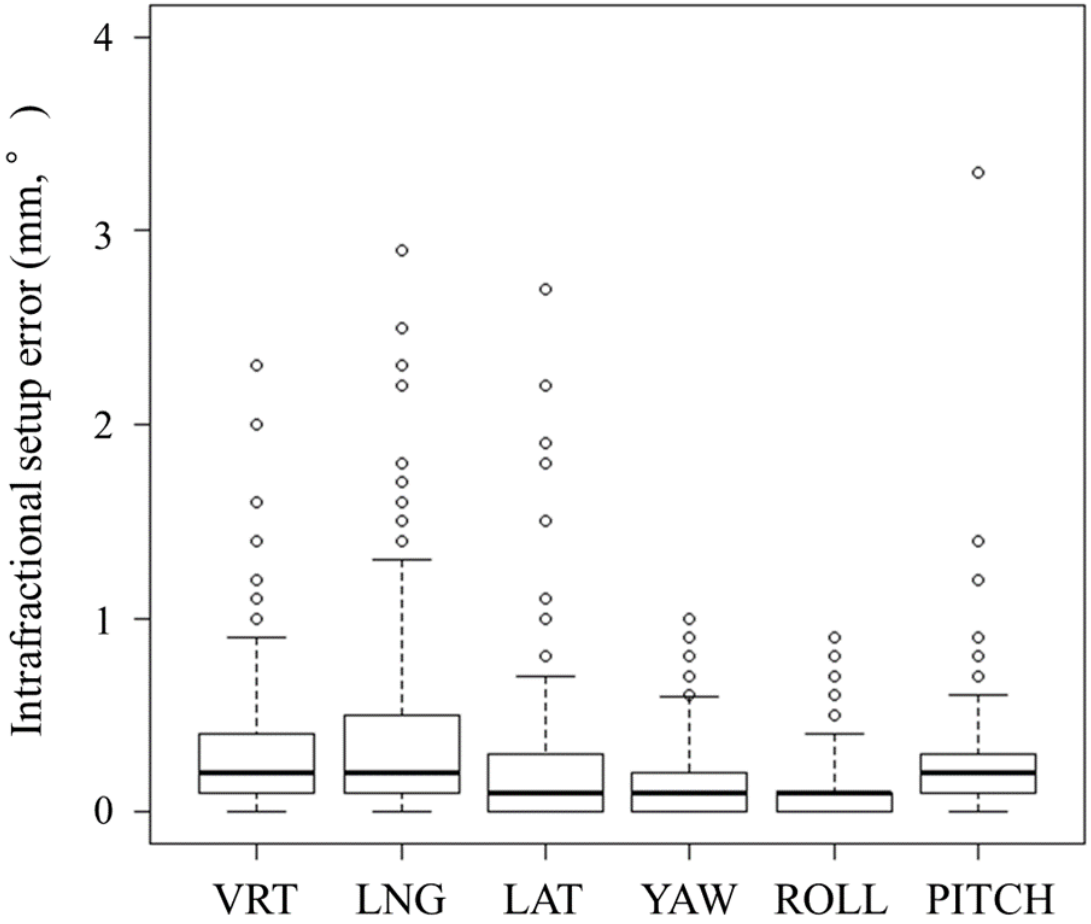
Definition of the intrafractional motion

Difference between the surface position before the start of irradiation and that just before the termination of irradiation

- The mean values for 4 s, **assuming the respiratory cycle**, were used as the values of AlignRT, because the value of AlignRT fluctuates owing to respiratory motion.



Intrafractional motion



- The maximum intrafractional error observed was 2.9 mm in the SI direction.
- The 95th percentile of translational motion was **below 1.4 mm**.
- The 95th percentile of the rotational motion was **below 0.7°** in all directions.
- The mean irradiation time for assessing intrafractional motion was 154 s.

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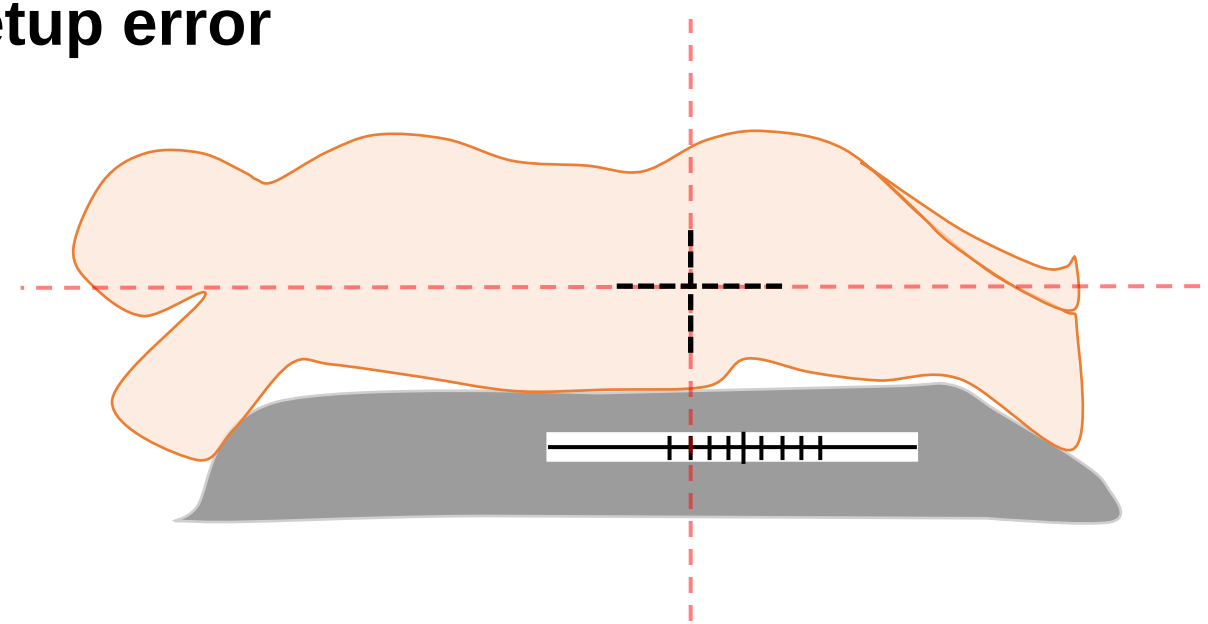
Setup procedure using AlignRT with belly board

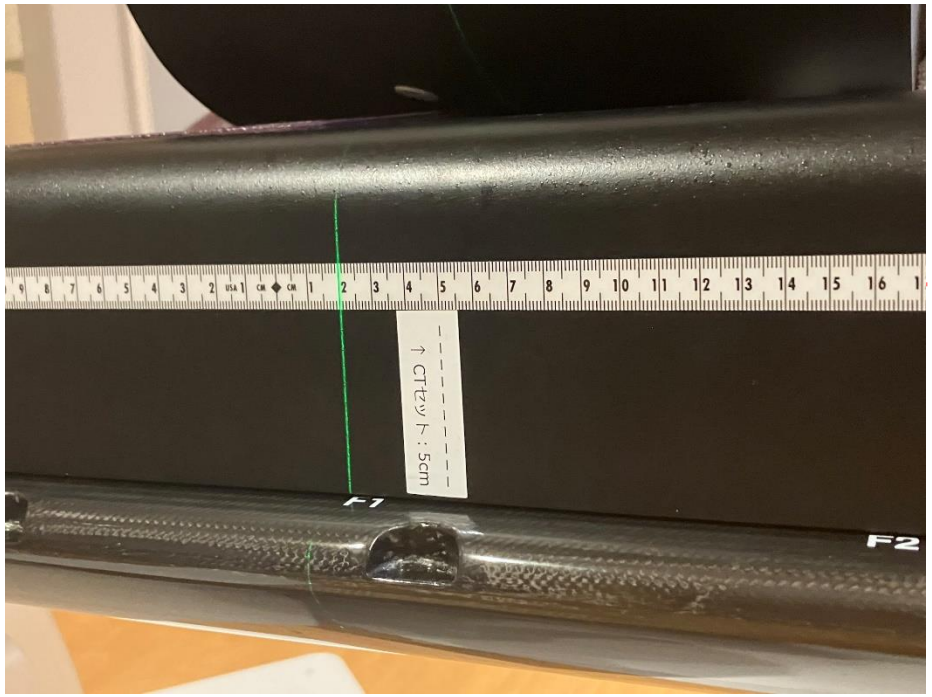
Key points for good positioning with belly board

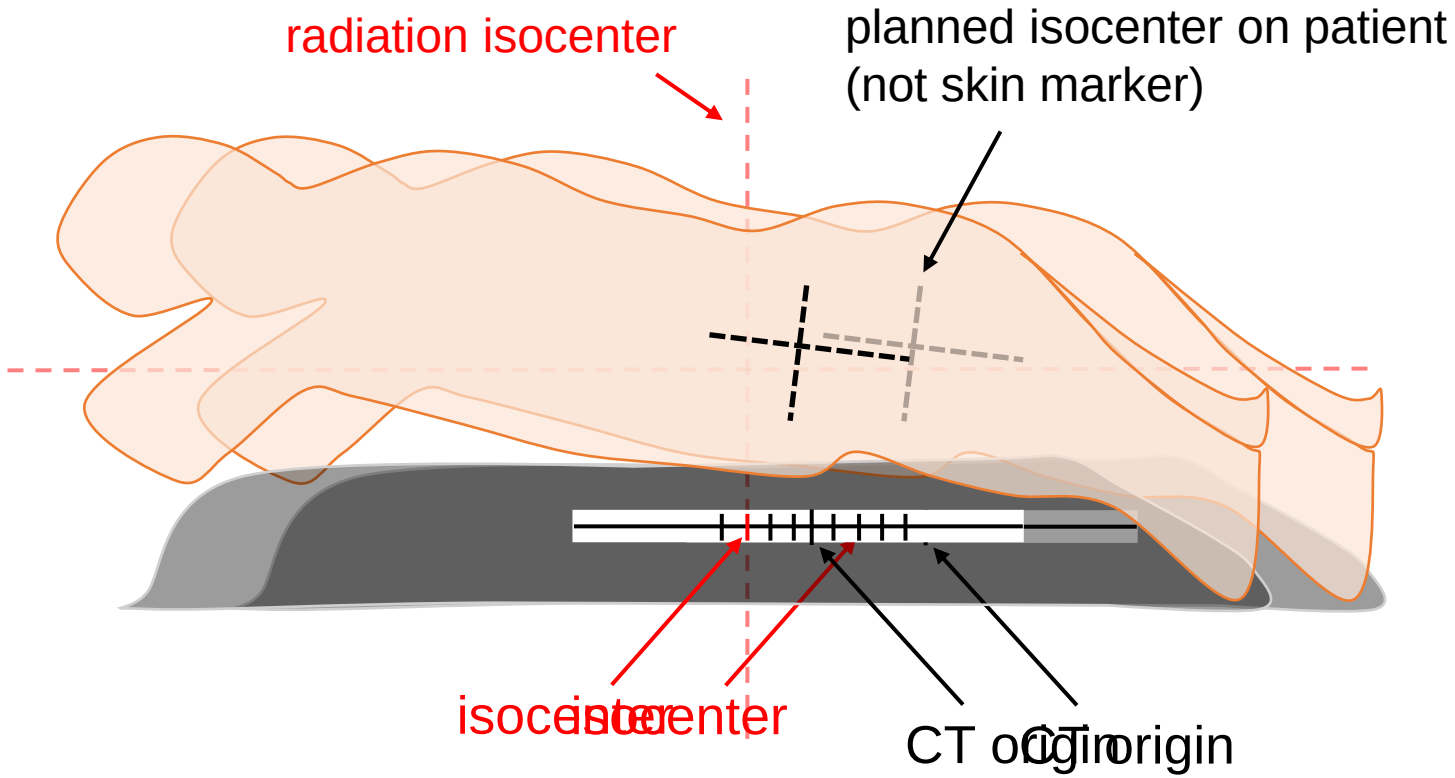
- ✓ **Reproducibility of the positional relationship between belly board and patient**
- ✓ **Minimizing rotational setup error**



Setup procedure using AlignRT with belly board

1. **Position the belly board at the isocenter in SI direction using the scale as a guide and fix the couch in place.**

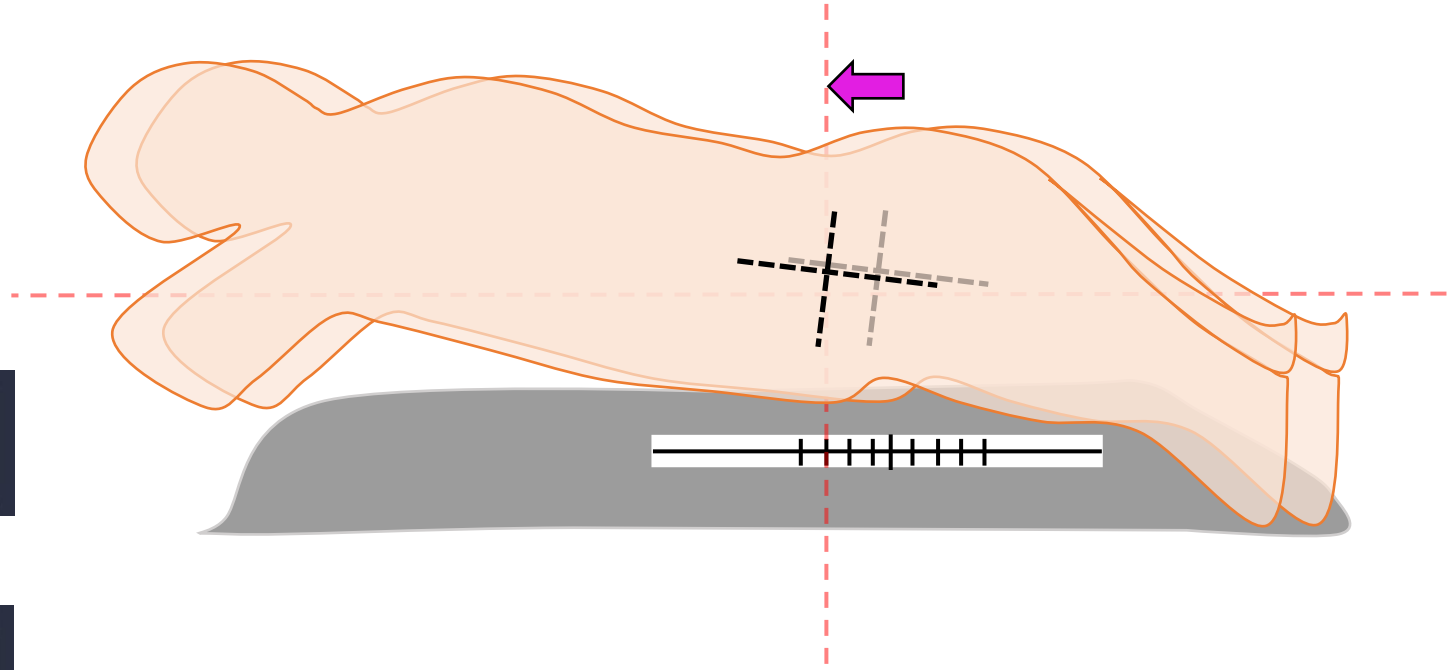




Setup procedure using AlignRT with belly board

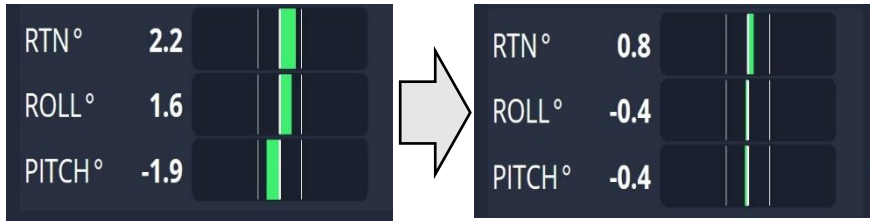
2. Adjust the patient's position so that the real-time delta in the SI direction is close to zero.

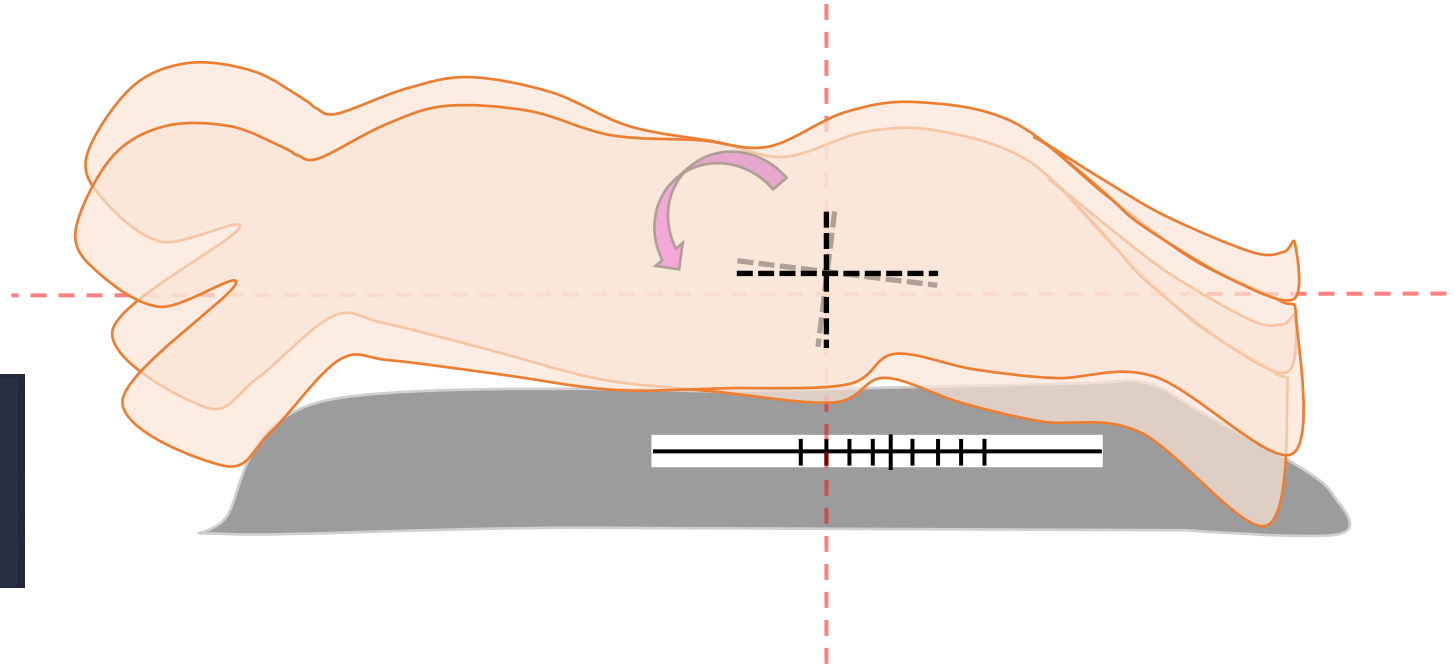
The positional relationship between the belly board and the patient should be the same as during CTS.



Setup procedure using AlignRT with belly board

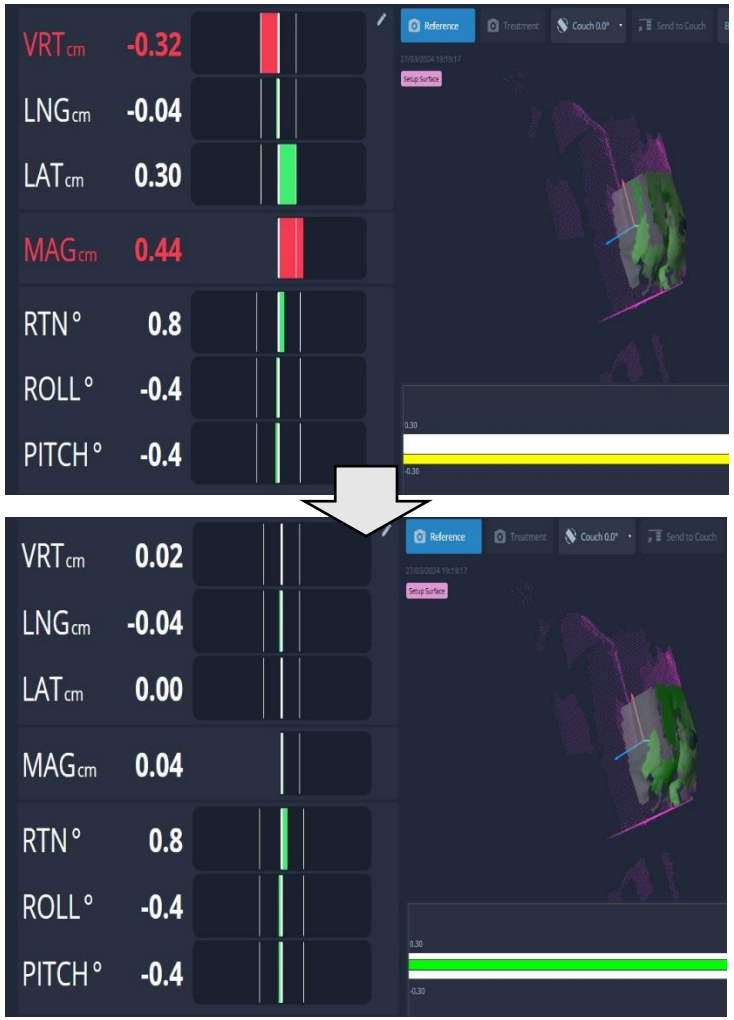
3. Correct the rotational setup errors with reference to real-time delta

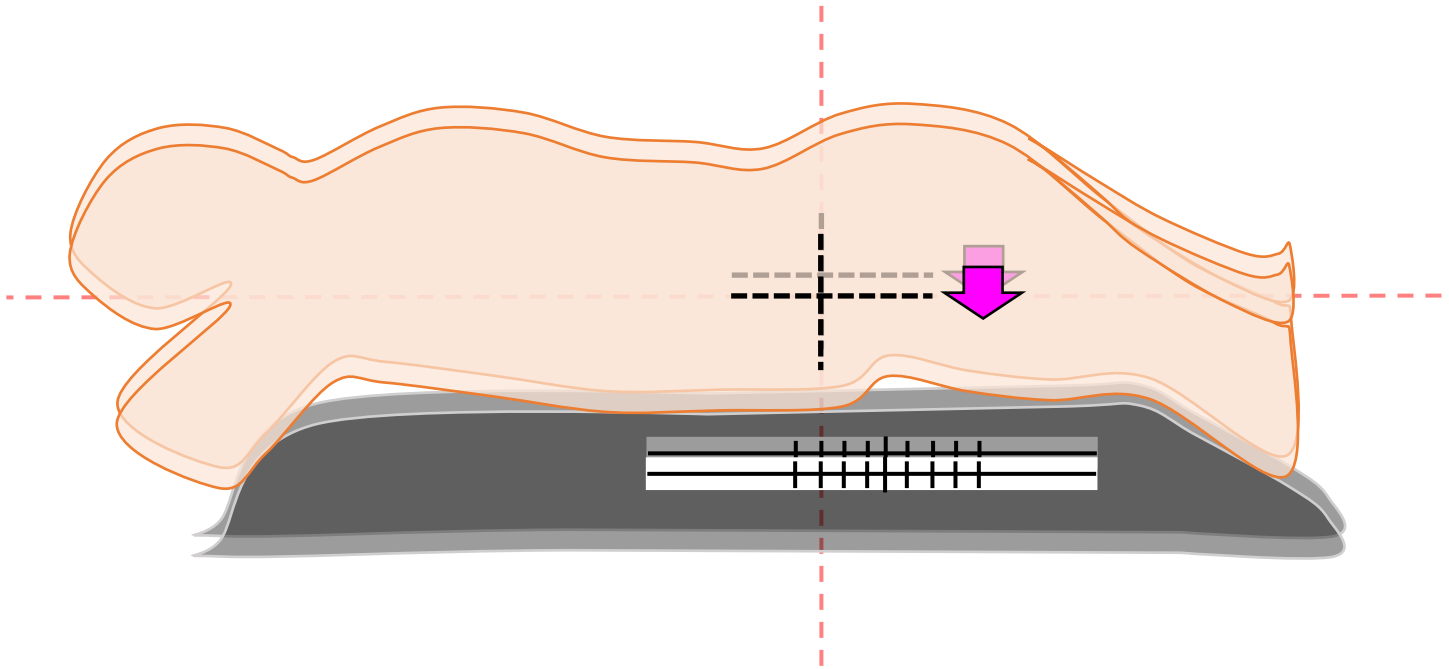




Setup procedure using AlignRT with belly board

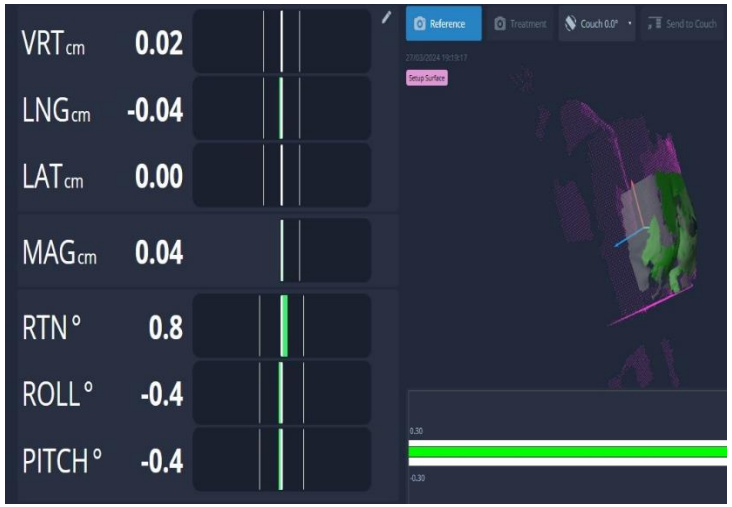
4. Correct the residual error with “send to couch” button

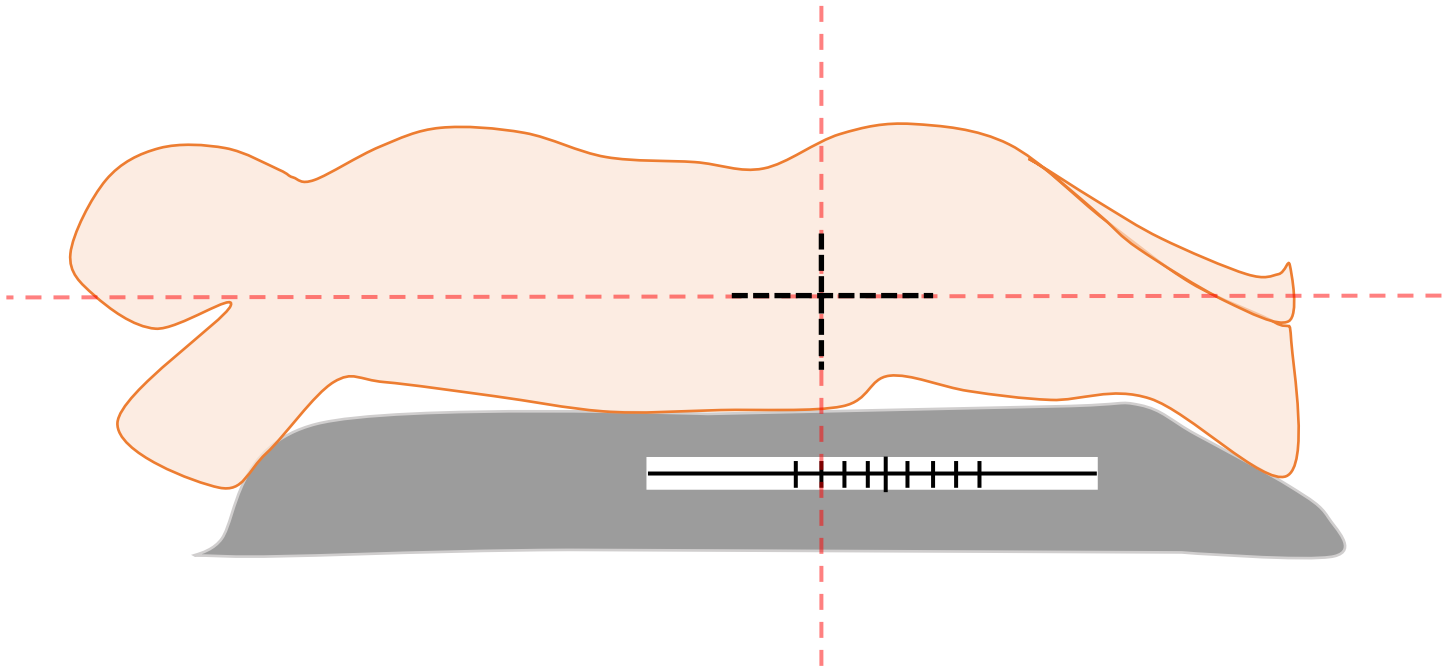




Setup procedure using AlignRT with belly board

5. Complete the patient setup with AlignRT → IGRT



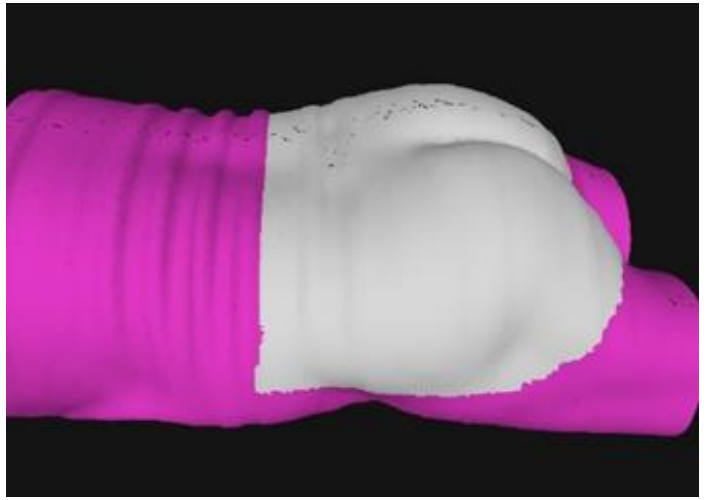


Summery

- **The SGRT system may improve the positioning accuracy for pelvic irradiation** in the prone position using a belly board device.
- **Intrafractional setup error was sufficiently small** to be tolerated.

Prone position for pelvic treatment

Surface guided radiotherapy




Thank you for kind attention