SGRT FOR CRANIOSPINAL IRRADIATION IN MEDULLOBLASTOMA

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Surface guidance in radiation therapy: old wine in new bottle?

Setup for treatment relies on→eyes of the clinician to set up the patient by visually aligning marks on the patient's skin surface to room lasers that represent the treatment isocenter→ ODI used to measure the SSD and the projection of the field light onto the surface of the patient→ Reference pictures of the planned setup →visual guide to verify that the setup is correct prior to treatment→patient is then visually monitored via closed-circuit television (CCTV) from outside the treatment vault to ensure that this position is maintained throughout the delivery of radiation

WHY SGRT

IGRT	SGRT
Cannot be used in real time during in-room patient setup - used in an iterative process to align the patient Cannot be used to continuously monitor for intra-fraction motion without adding additional radiation dose to the patient	Cannot image subsurface targets and relies on the surface as a surrogate for internal target position Can offer psychosocial benefits from reduced skin marking

SGRT is complementary to IGRT and has an important role in the accurate and precise delivery of radiation therapy

WHY SGRT

- Surface-guided radiotherapy (SGRT) using optical surface imaging (OSI), as a special form of image-guided radiotherapy (IGRT)
- Advantages of SGRT
  - nonionization radiation 3D imaging with the patient's external anatomy
  - real-time 4D imaging for motion tracking and threshold gating
- OSI system allows for

  (1) quick in-room patient setup with initial surface alignment

  (2) establishing a new OSI reference image for motion monitoring after the CBCT setup

  (3) verification of the patient position at each planned couch angle, and

  (4) real-time OSI motion monitoring at 3–4 Hz frame rate during treatment

Application of SGRT in Pediatric Patients

- Markerless tracking for 4D image reconstruction
- Biometric patient identification
- Immobilization device identification
- In-room scene mapping
- Because SGRT is non-ionizing and has a FOV that is larger than other IGRT systems, this opens up the possibility to generate additional 3D information by scene mapping essentially acquiring a 3D surface image of the treatment room that can be utilized for various purposes.

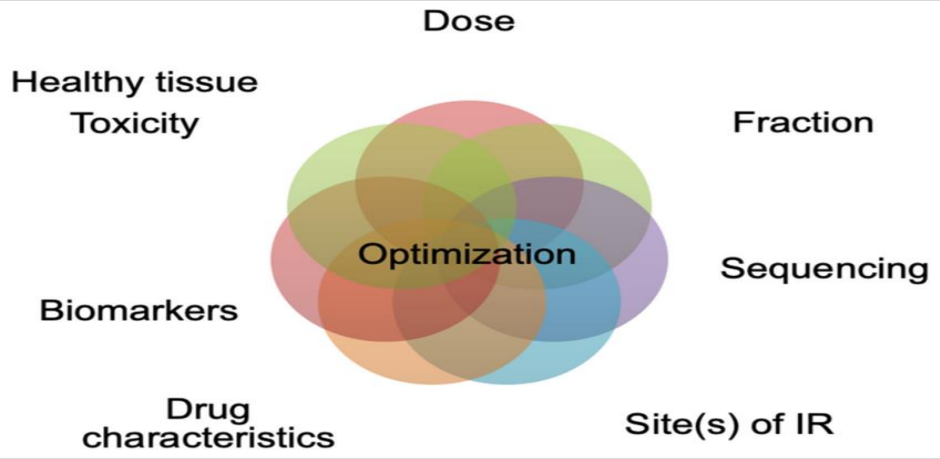
Why SGRT in CSI?

- Get another degree of confidence for setup and monitoring a complicated treatment protocol
- Intrafraction monitoring for patients
- Attempt to make treatment more comfortable for patients
- ‘cos we got it?

CSI AND SGRT

Challenges in CSI

- Multiple fields: coplanar and non coplanar
- Junctions
- Strict immobilization

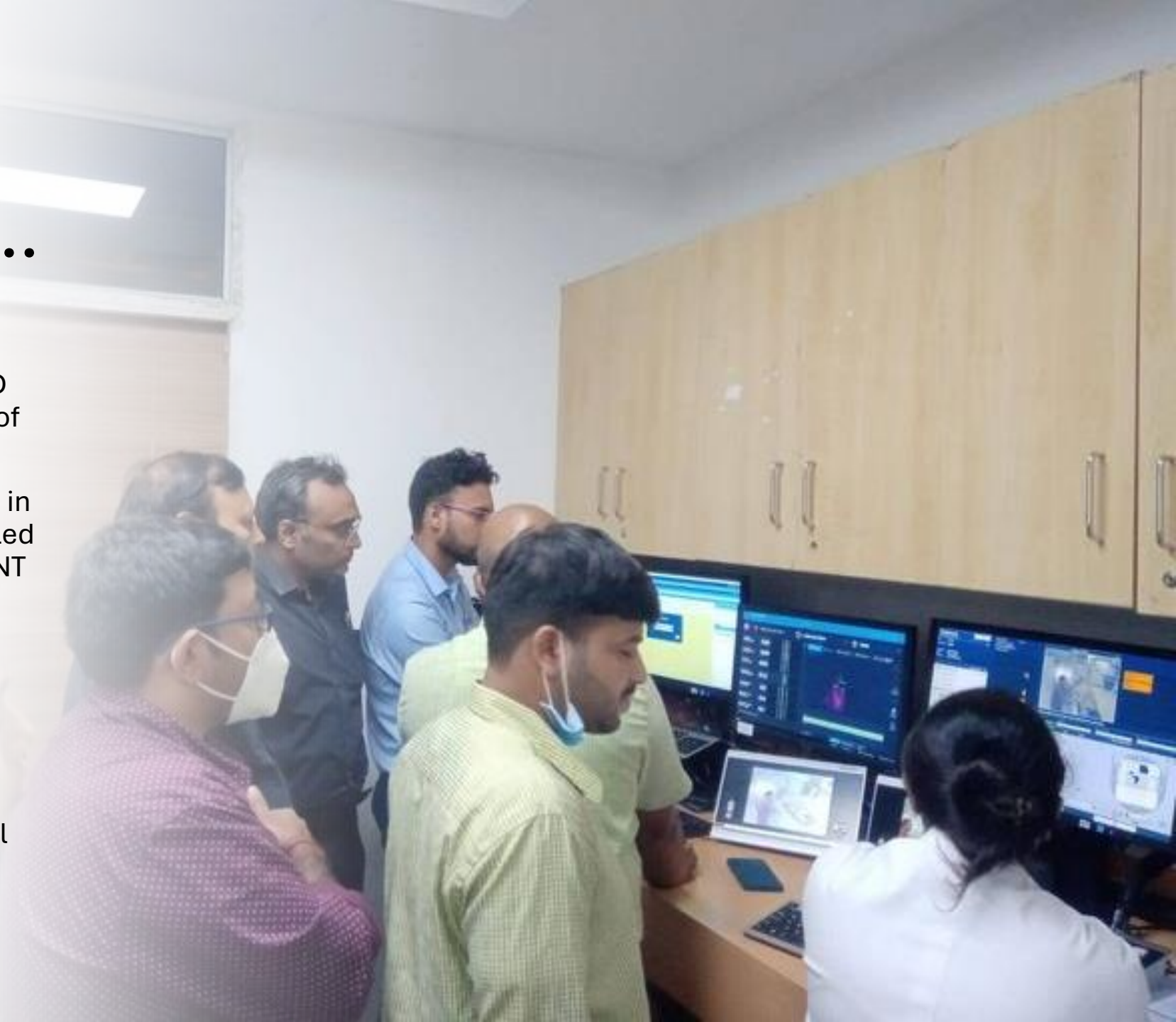


SGRT

- SGRT allows both patient positioning with real time feedback and patient monitoring throughout treatment fraction by infrared radiation based imaging of patient surface.
- This real time surface is then registered to an initial reference surface relative to the treatment isocenter position(based on planning CT set up) to calculate the necessary correction of the patient position in translational and rotational directions without any immobilisation devices.

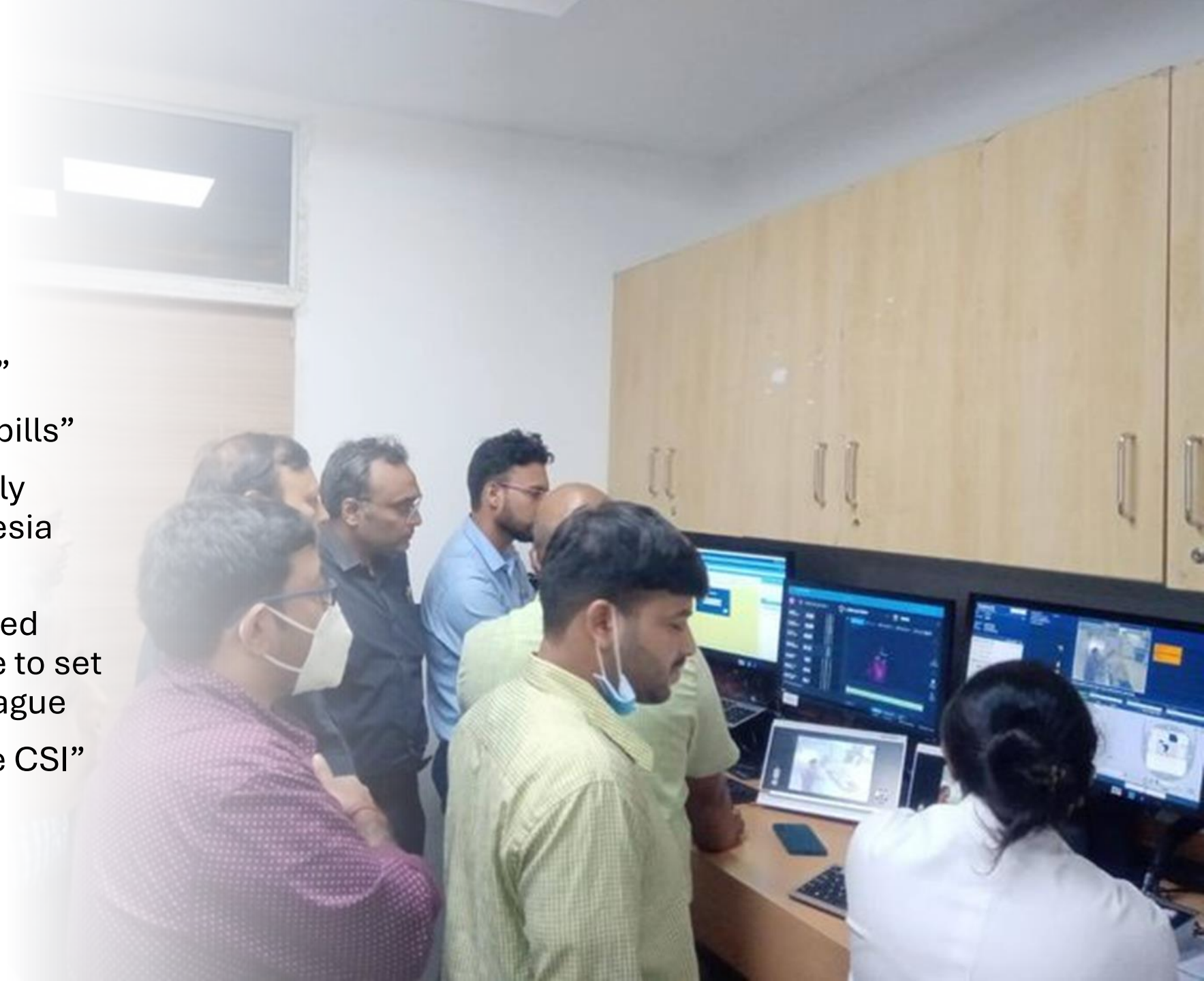
Our patient who made us do this...

- 13 year old female presented at OPD as a post operative diagnosed case of Medulloblastoma: standard risk
- She underwent gross total resection in June,2023 and post op biopsy revealed Medulloblastoma, WHO Grade 4,WNT activated, beta catenin mutant.
- Post op MRI revealed no obvious residual or recurrent lesion at operative site and MRI screening of whole spine revealed no metastatic lesions
- Plan CSI f/b PF boost as per protocol



Problems?

- “ I will not wear a mask!”
- “I will not take sleeping pills”
- “Your patient is extremely uncooperative”-Anesthesia team
- “Sir the patient has moved again during RT will have to set up again” RT Tech Colleague
- “Please consider supine CSI” Med Physics colleague



Approach: treat patient without immobilization device using SGRT

WHY?

- SGRT allowed both patient positioning with real time feedback and patient monitoring throughout treatment fraction by infrared radiation based imaging of patient surface.
- Real time surface registered to an initial reference surface relative to the treatment isocenter
- Any positional changes calculated from patient position in translational and rotational directions without any immobilization devices in real time

Treatment positioning data compared with immobilization device based treatment

Standard Workflow

3-point laser based set up was done with help of reference body markings/tattoos

↓

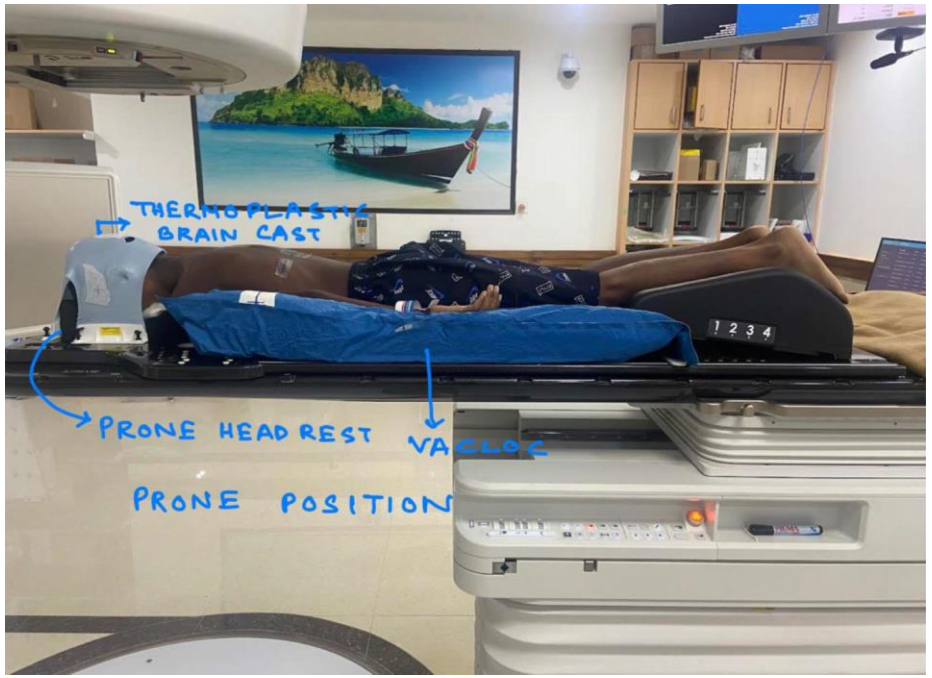
Junctions were
also marked on body surface.

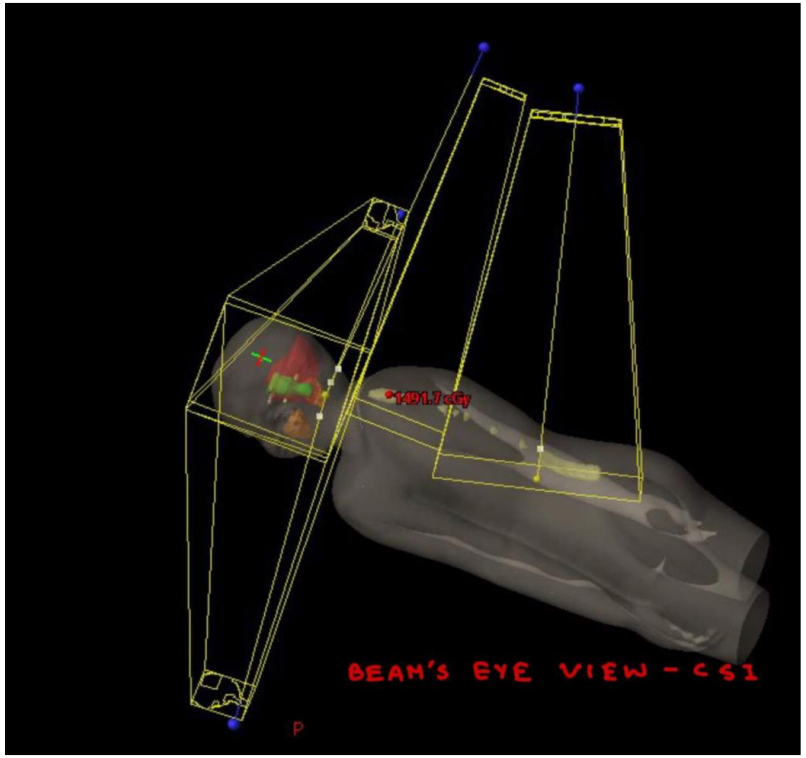
↓

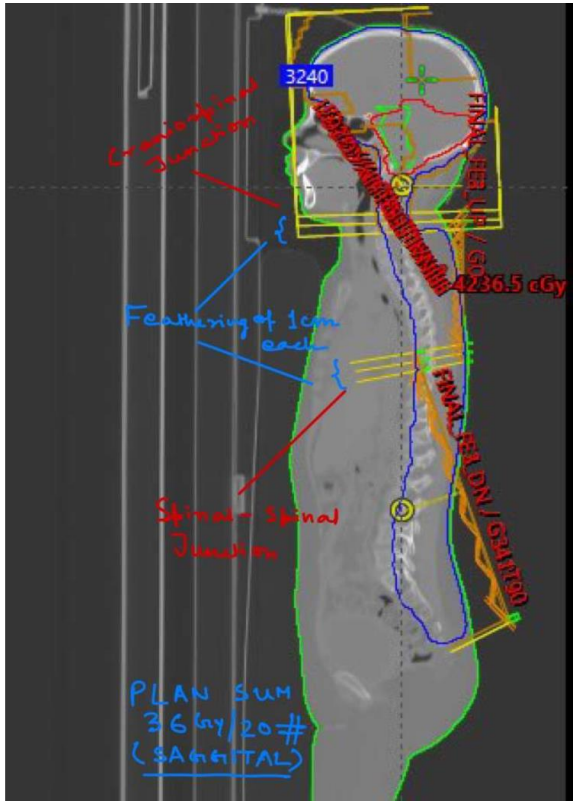
verification of
setup position was carried out with orthogonal Xray as well as with cone beam CT scan imaging

↓

Treatment delivered after applying necessary shift if any







SGRT Workflow

patient was treated without thermoplastic brain cast using SGRT based surface matching

↓

reference surface was extracted from the planning CT or a captured surface of the patient at an IGRT guided validated position and a real time 3D surface then coregistered with it to calculate the shifts in translational directions.

↓

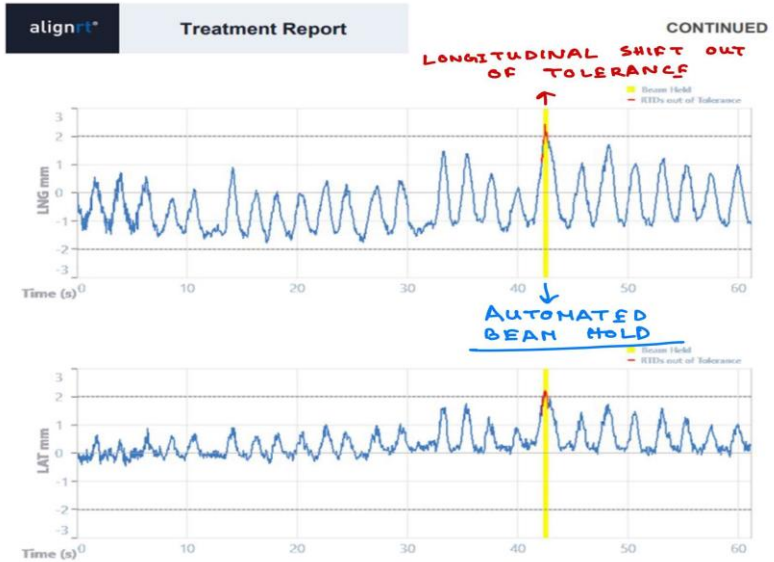
After applying the necessary shift it was confirmed by orthogonal x ray and cone beam CT as well before treatment delivery.

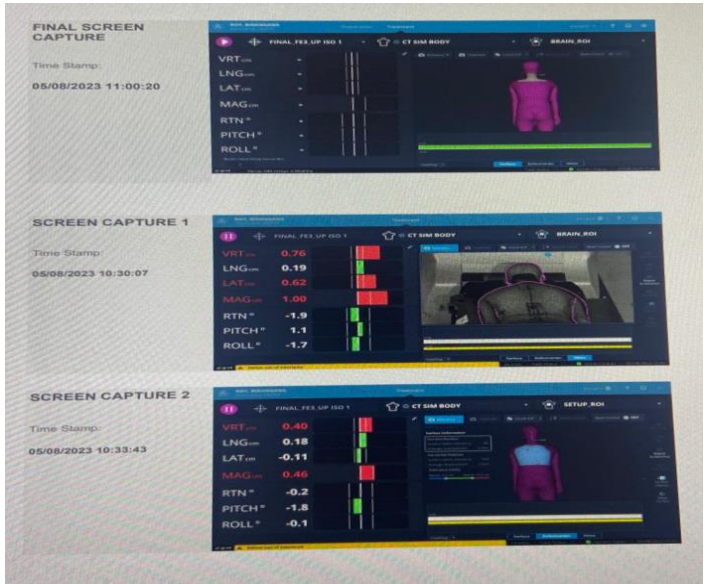
↓

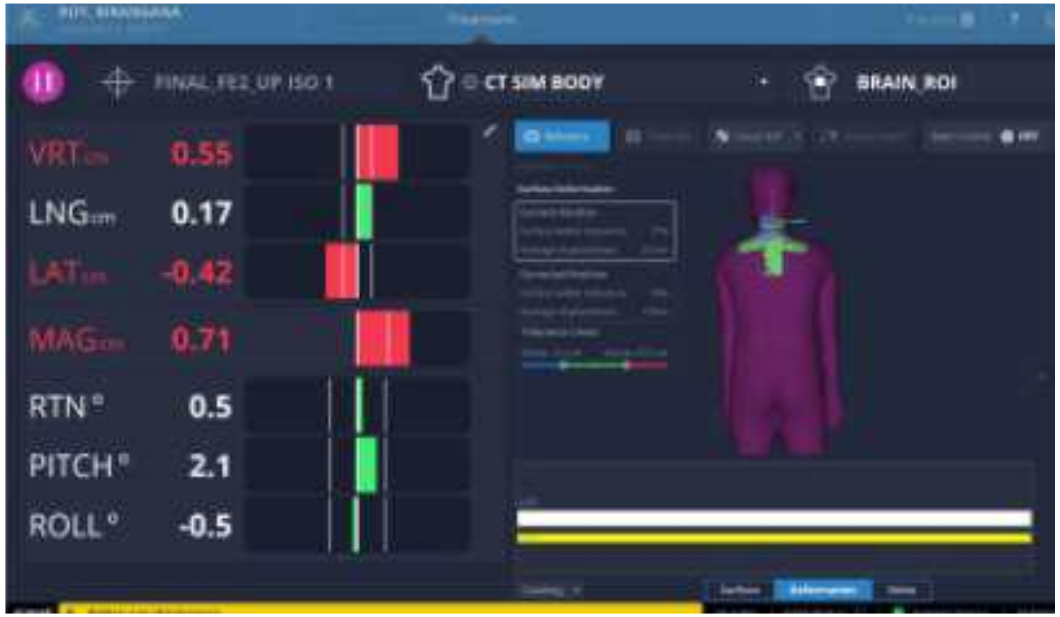
The patient was also constantly being monitored during fraction with projector and ceiling based multiple cameras of SGRT setup.

↓

The beam was programmed to be held if parts of the patient's surface deviate from the reference position based on the planning CT set up, the threshold for this automated beam shut off was set at 2mm for any translational shift and 2 degree for any rotational shift.



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MAG cm 0.71
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PITCH ° 2.1
ROLL ° -0.5


FINAL_FE5_DN ISO 1
CT SIM BODY
LUMBER_ROI
VRT cm 1.43
LNG cm -0.29
LAT cm -0.44
MAG cm 1.54
RTN ° -1.5
PITCH ° -1.7
ROLL ° 2.0


CSI_FE1_DN ISO 1
CT SIM BODY
ROI2
VRT cm 0.16
LNG cm 0.10
LAT cm -0.05
MAG cm 0.24
YAW ° 7.8
ROLL ° -0.7
PITCH ° -0.2

AVG. SHIFT	FIELDS/ROI	VERTICAL	LONGITUD	LATERAL
SHIFT IN CBCT ONLY BASED SETUP	CRANIAL	0.42 cm	0.63cm	0.2 cm
	SPINAL	0.84 cm	0.27 cm	0.11 cm
SHIFT IN SGRT BASED SETUP	SETUP ROI	0.37 cm	0.44 cm	0.35 cm
	BRAIN ROI	0.63 cm	0.16 cm	0.21 cm
	LUMBAR ROI	0.16 cm	0.16 cm	0.22 cm
SHIFT IN CHECK CBCT AFTER SGRT BASED SETUP	CRANIAL	0.03 cm	0.06 cm	0.02 cm
	SPINAL	0.07 cm	0.01 cm	0.02 cm

The check orthogonal x ray and CBCT post SGRT algorithm guided correction successfully confirmed the accuracy of SGRT based set up as the shifts were negligible in all translational and rotational directions Intrafraction movement during treatment were within the set threshold and All treatments were delivered successfully.

Our observations..

SGRT COVERS THE ENTIRE WORKFLOW FROM SETUP TO END OF TREATMENT, PROVIDING IMAGES THAT ARE EASIER AND FASTER TO INTERPRET.

PATIENT'S COMPLIANCE IS MORE IN SGRT BASED SETUP AS IT DOESN'T WARRANT THERMOPLASTIC BRAIN CAST OR OTHER IMMOBILIZATION DEVICES.

IT CAN SIGNIFICANTLY REDUCE THE ON COUCH PATIENT TIME.

BY INTEGRATING THE AUTOMATED BEAM OFF MECHANISM WITH LINAC,IT CAN SIGNIFICANTLY REDUCE THE POSSIBILITY OF ERRONEOUS DOSE DISTRIBUTION DUE TO UNWANTED JUNCTION GAP OR OVERLAP -AN ADDITIONAL LEVEL OF SAFETY IN THE WORKFLOW OF CSI TREATMENT.

IT HAS POTENTIAL BENEFITS SPECIFICALLY IN PEDIATRIC PATIENTS INCLUDING ENHANCING SETUP AND NEED OF GENERAL ANESTHETIC.

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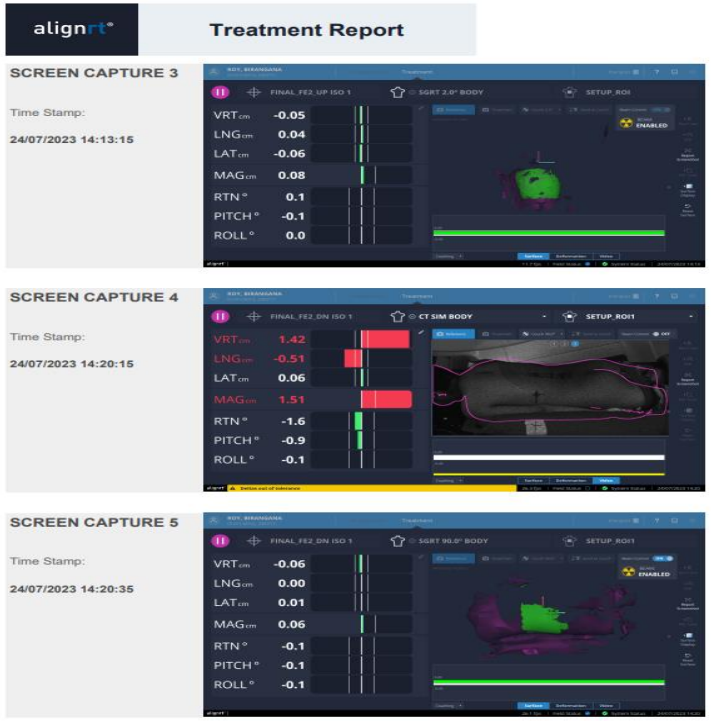
- Entire Medical Technologist team Led by Mr Hindol Banerjee
- Mr Krishna Ramesh
- Our little princess whose tantrums compelled us to think outside the box!

Thank you


alignrt
Treatment Report
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RTN 0.1
PITCH -0.1
ROLL 0.0
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VRT 1.42
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MAG 1.51
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