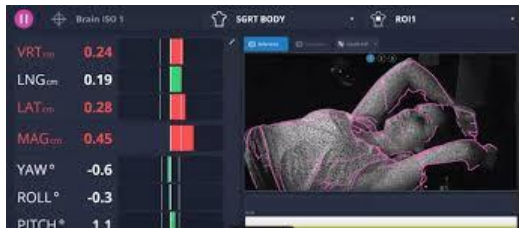


ANADOLU
In Affiliation with
JOHNS HOPKINS MEDICINE

THE IMPORTANCE of SGRT in CURRENT CLINICAL PRACTICE: RADIATION ONCOLOGIST PERSPECTIVE

Hale Basak CAGLAR

Anadolu Medical Center

Department of Radiation Oncology

Turkey

OVERVIEW

- Introduction
  - The team
  - The hospital
  - Treatment Platforms
- SGRT
- Evidence
- Indications
- Workflow – case examples

INTRODUCTION

- The team
  - 4 radiation oncologists
  - 4 physicist
  - 3 dosimetrist
  - 10 technologist
  - 3 nurse
- All radiation therapies except brachytherapy
  - Well known for radiosurgery (50%)

INTRODUCTION

ANADOLU
In Affiliation with
JOHNS HOPKINS MEDICINE

- The hospital
  - Stand alone private hospital
  - Established in 2005
  - Affiliated to Johns Hopkins International
  - Mainly oncology
  - Strong international department
  - Member of ESMO
  - Member of EORTC
  - Member of OECI
- The team met with the hospital in 5/2017

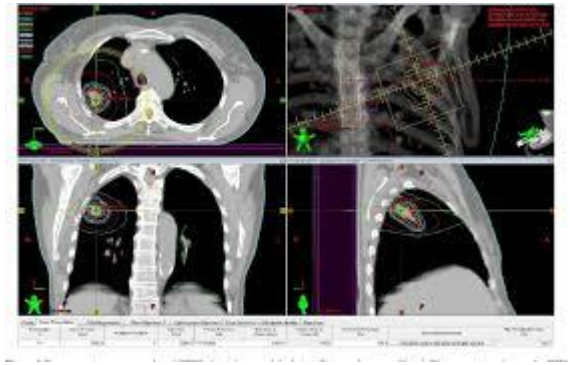
TREATMENT PLATFORMS

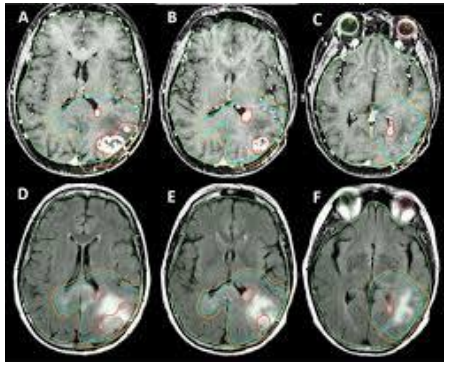
- Varian Edge
  - SGRT – Vision RT
  - Hyperarc
  - iCBCT
  - HD MLC
- CyberKnife S7
  - MLC
  - Precision
  - IDMS
  - Volo

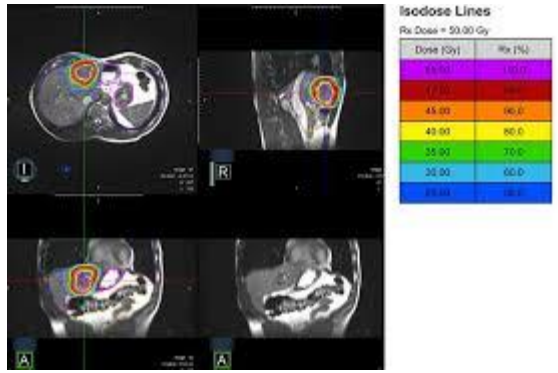
- Radixact
  - Precision
  - C-True
  - Precise ART – RTX
- IORT – Xoft
- Elekta Unity MR Linac

ADVANCES IN RADIATION TREATMENTS

- Higher doses
- Smaller targets
- Narrow margins
- Predefined anatomies
- Motion
  - Predictable
  - Unpredictable







- Image guidance becomes key!!!

INTEGRATION of RADIOGRAPHIC IMAGE GUIDANCE with NON-RADIOGRAPHIC LOCALIZATION

- Marker-based
  - Passively track a reflective marker with an imaging system operating in the infrared spectrum
  - Actively track a radiofrequency (RF) beacon using a set of RF receivers
- Surface-based
  - Advances in computing power and imaging technology allow the mapping of many arbitrary points on the patient while simultaneously tracking their position over time
  - These points comprise a 3D surface and can be considered an extension of a marker-based approach, with a corresponding improvement in the ability to relate a patient's current position and posture to a reference

SURFACE GUIDED RADIATION THERAPY (SGRT)

- Video-based 3D surface imaging system
- Used to detect and reconstruct the skin surface of a patient in 3D before and during the radiotherapy treatment
- Non-invasive
- Real-time
- Non-ionizing

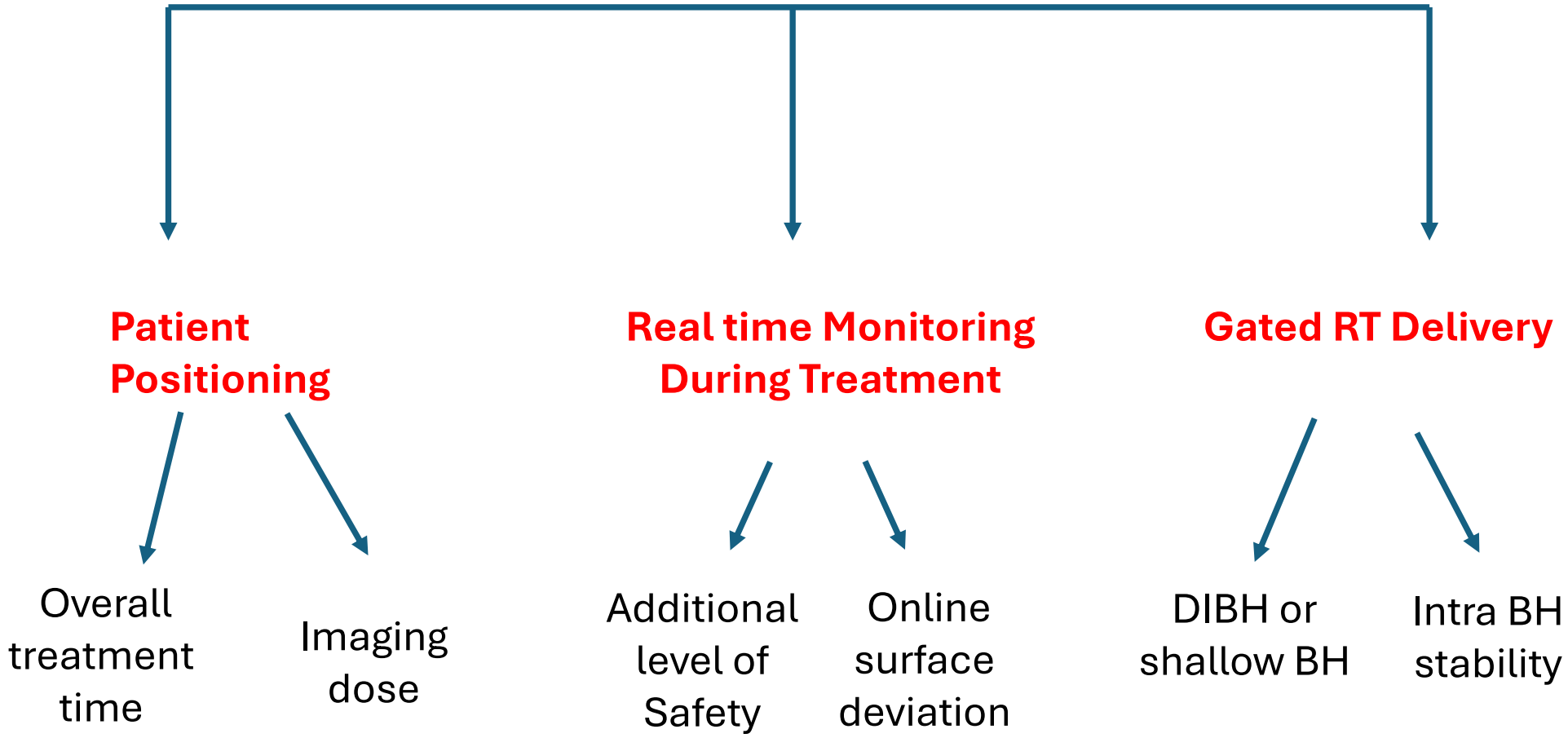
WHAT ARE THE ADVANTAGES?

- Enables reduction of initial set-up variability
- Decreases set-up time
- Provides verification of immobilization continuously during treatment
  - Non-coplanar linac gantry angles
- Provides dynamic surface information for use in gated and breath-hold treatment techniques

WHAT ARE THE ADVANTAGES?

- Permit reductions in the margins required to account for target localization uncertainty
- The ability to use immobilization techniques that confer greater comfort to patients
- Reduction in imaging dose through reduced radiographic localization requirements
- Improvements to the speed, efficiency, and safety of clinical workflows

WHY DO WE PREFER TO USE SGRT?



WHY DO WE PREFER TO USE SGRT?

- **Patient positioning:**
- **In-room online information** of the complete surface and position of the patient

- **For superficial tumors** (where surface deviations can act as a surrogate for tumor motion)
  - More accurate positioning compared to 3-point-lasers
  - Reduce the number of daily imaging in some cases

- **For deeper located tumors** (with no direct correlation between surface deviations and tumor movement)
  - Daily imaging remains mandatory
  - SGRT can reduce the time required for image registration
  - Prevent the need for multiple imaging

WHAT IS THE CURRENT EVIDENCE ?

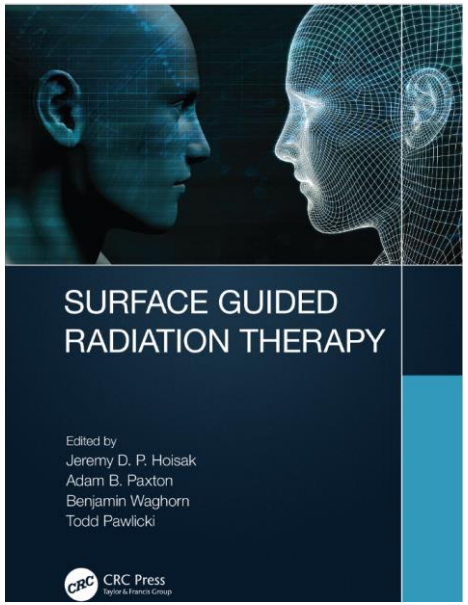
International Journal of Radiation Oncology biology • physics
www.redjournal.org

Physics Contribution

Accuracy Evaluation of a 3-Dimensional Surface Imaging System for Guidance in Deep-Inspiration Breath-Hold Radiation Therapy

Tanja Alderliesten, PhD, Jan-Jakob Sonke, PhD, Anja Betgen, MSc, Joeri Honnef, MSc, Corine van Vliet-Vroegindeweij, PhD, and Peter Remeijer, PhD

Department of Radiation Oncology, The Netherlands Cancer Institute—Antoni van Leeuwenhoek Hospital, Amsterdam, Netherlands



Radiation Oncology

BioMed Central

Research

Open Access

Reproducibility of patient setup by surface image registration system in conformal radiotherapy of prostate cancer

Marco Krengli*[1,2], Simone Gaiano[1], Eleonora Mones[3], Andrea Ballarè[1], Debora Beldì[1], Cesare Bolchini[1] and Gianfranco Loi[3]

WHAT IS THE CURRENT EVIDENCE ?

International Journal of Radiation Oncology biology • physics

www.redjournal.org

Physics Contribution

Evaluation of the Accuracy of a 3D Surface Imaging System for Patient Setup in Head and Neck Cancer Radiotherapy

Olga Gopan, M.S.,* and Qiuwen Wu, Ph.D.†

*Department of Radiation Oncology, Wayne State University, Detroit, Michigan; and †Department of Radiation Oncology, Duke University Medical Center, Durham, North Carolina

Received May 3, 2011

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Contents lists available at ScienceDirect

Physica Medica

journal homepage: http://www.physicamedica.com

REVIEW PAPER

IGRT and motion management during lung SBRT delivery

Vincent Caillet [a,b,*], Jeremy T. Booth [a,b], Paul Keall [c]

[a] Northern Sydney Cancer Centre, Royal North Shore Hospital, Sydney, Australia
[b] School of Physics, University of Sydney, Sydney, Australia
[c] School of Medicine, University of Sydney, Sydney, Australia

ELSEVIER

Medical Dosimetry

journal homepage: www.meddos.org

Accuracy evaluation of the optical surface monitoring system on EDGE linear accelerator in a phantom study

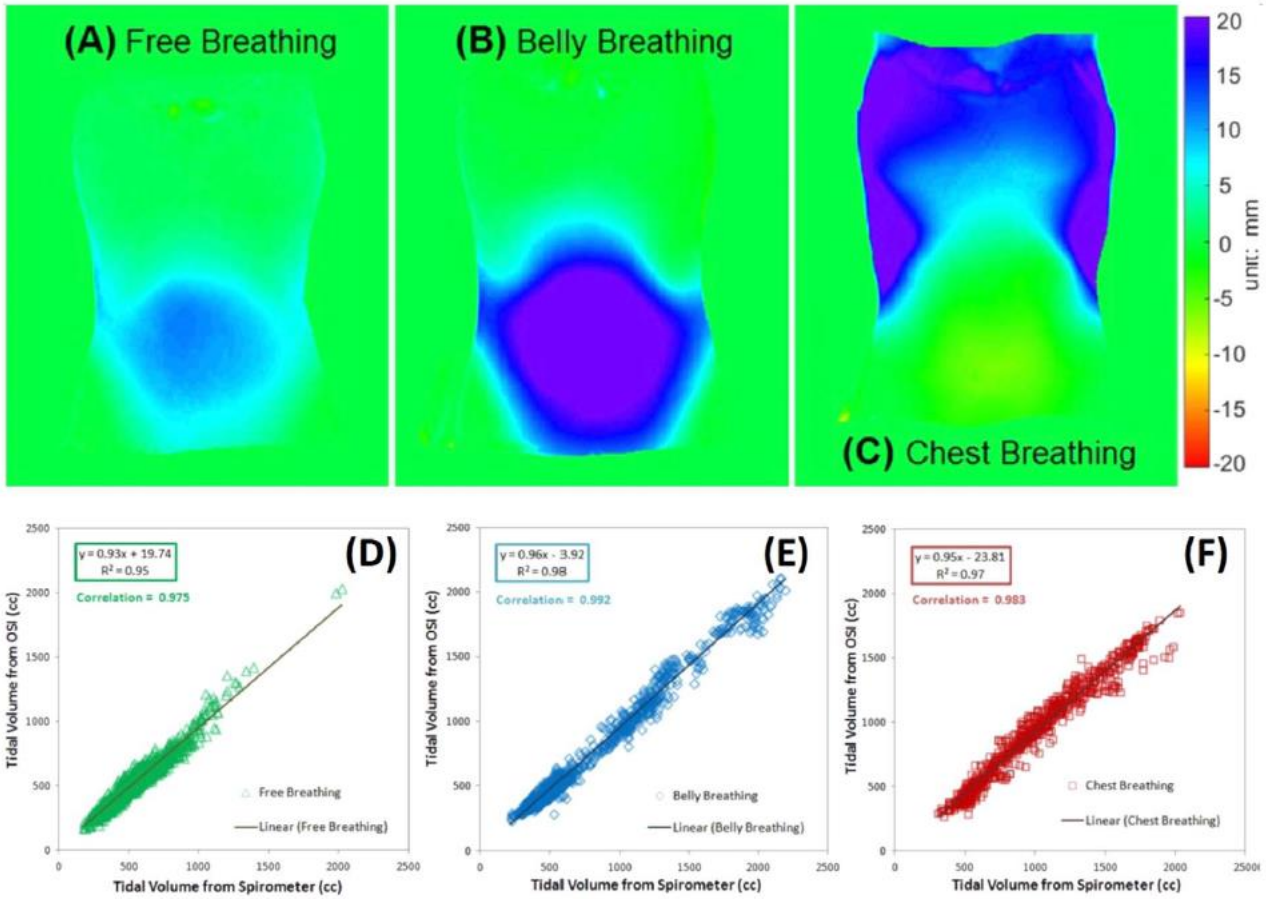
Pietro Mancosu, M.Sc., Antonella Fogliata, M.Sc., Antonella Stravato, M.Sc., Stefano Tomatis, M.Sc., Luca Cozzi, Ph.D., and Marta Scorsetti, M.D.

Radiotherapy and Radiosurgery Department, Humanitas Clinical and Research Center, Milan-Rozzano, Italy

WHAT DO THE EVIDENCE SAY?

- Review of in room IGRT methods before and during lung SBRT
- The SGRT systems is advantageous in detecting unexpected patient motion (cough etc)
- Breath hold treatments can be done more efficiently

CORRELATION OF RESPIRATION WITH SURFACE INFORMATION



Characterization of optical-surface-imaging-based spirometry for respiratory surrogating in radiotherapy

Guang Li[a)]
Department of Medical Physics, Memorial Sloan Kettering Cancer Center, New York, New York 10065

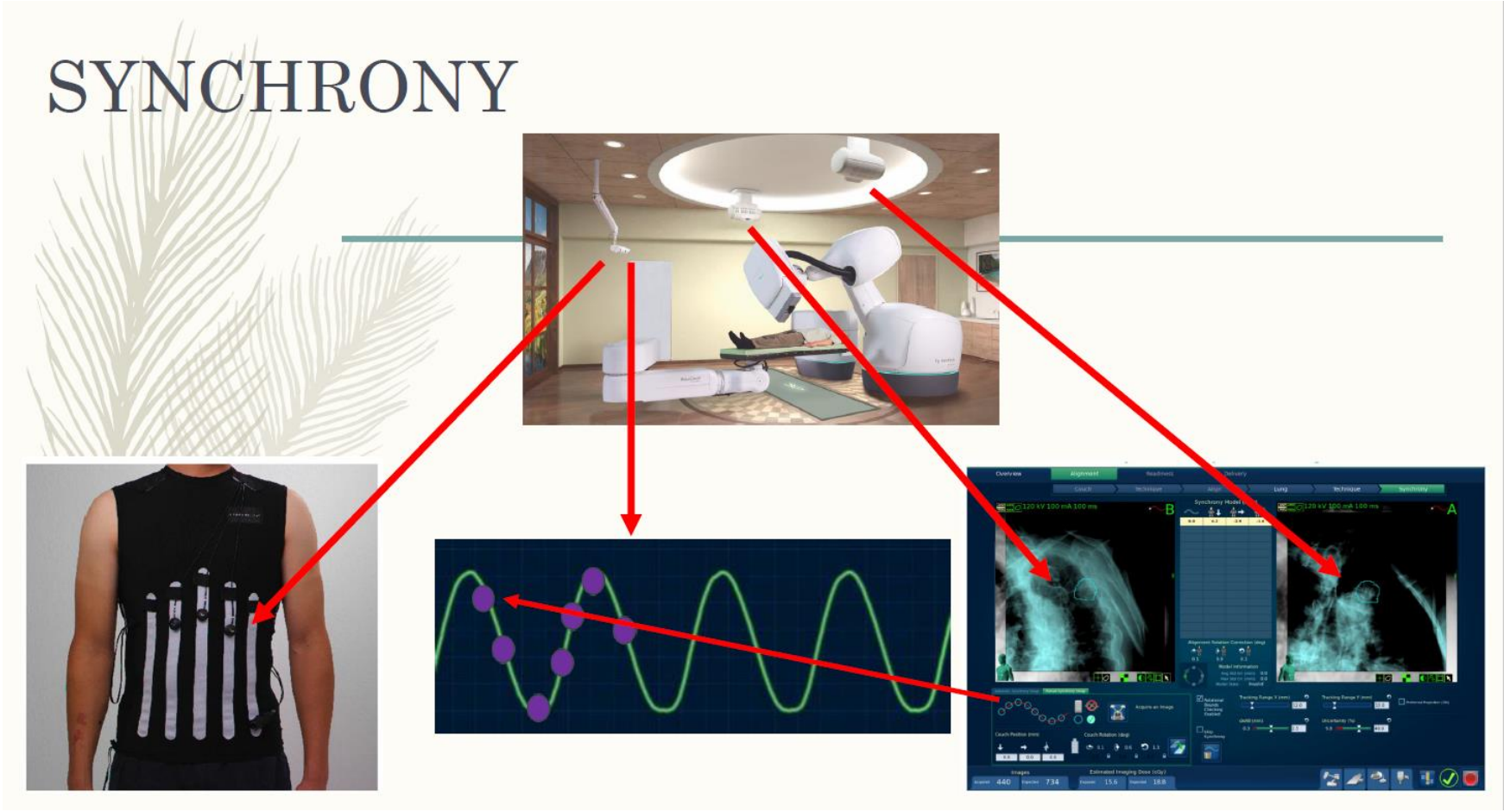
Jie Wei
Department of Computer Science, City College of New York, New York, New York 10031

Hailiang Huang, Qing Chen, Carl P. Gaebler, Tiffany Lin, and Amy Yuan
Department of Medical Physics, Memorial Sloan Kettering Cancer Center, New York, New York 10065

Andreas Rimner
Department of Radiation Oncology, Memorial Sloan Kettering Cancer Center, New York, New York 10065

James Mechalakos
Department of Medical Physics, Memorial Sloan Kettering Cancer Center, New York, New York 10065

CORRELATION OF RESPIRATION WITH SURFACE INFORMATION



PREDICTION of MOTION by SURFACE GUIDANCE

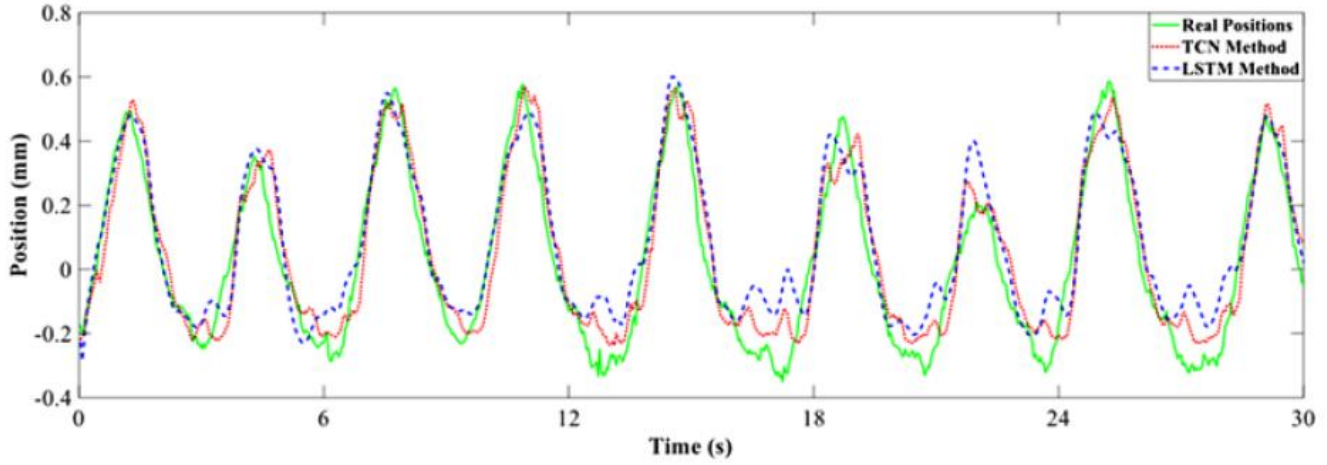
JOURNAL OF MEDICAL INTERNET RESEARCH Chang et al

Original Paper

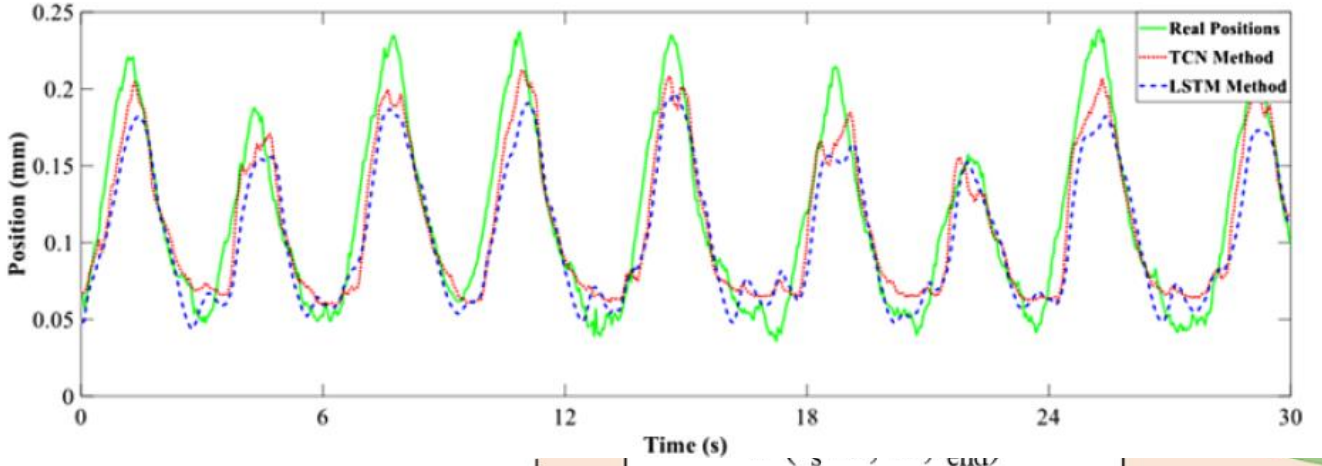
Real-Time Respiratory Tumor Motion Prediction Based on a Temporal Convolutional Neural Network: Prediction Model Development Study

Panchun Chang[1,2*], MA; Jun Dang[1*], PhD; Jianrong Dai[3], PhD; Wenzheng Sun[4], PhD

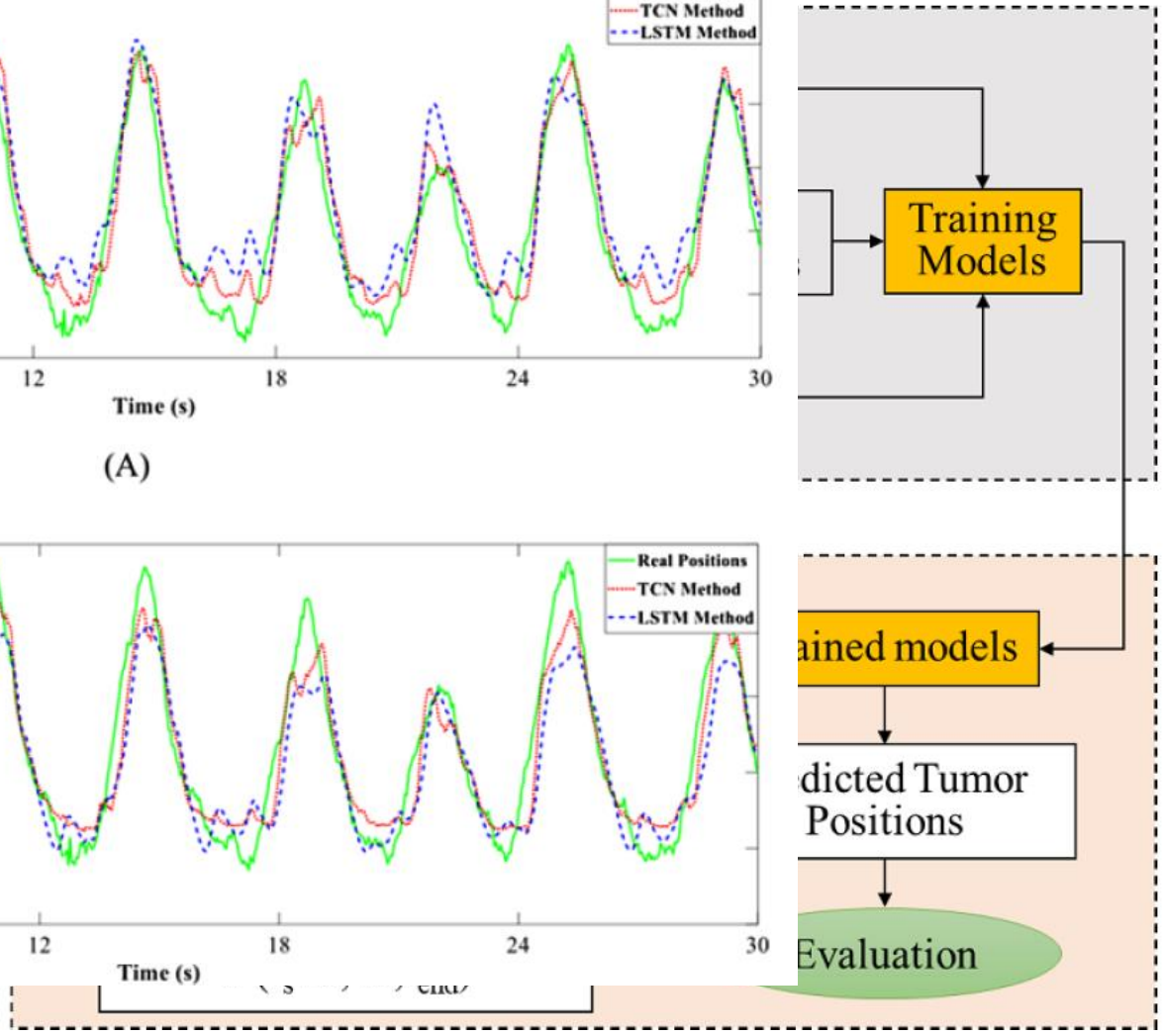
Figure 1. Flow



(A)



Each Pa
T/M



BASIC COMPONENTS OF THE SYSTEM at ASM

Main workstation

Vision RT PC

At treatment console

Workstation

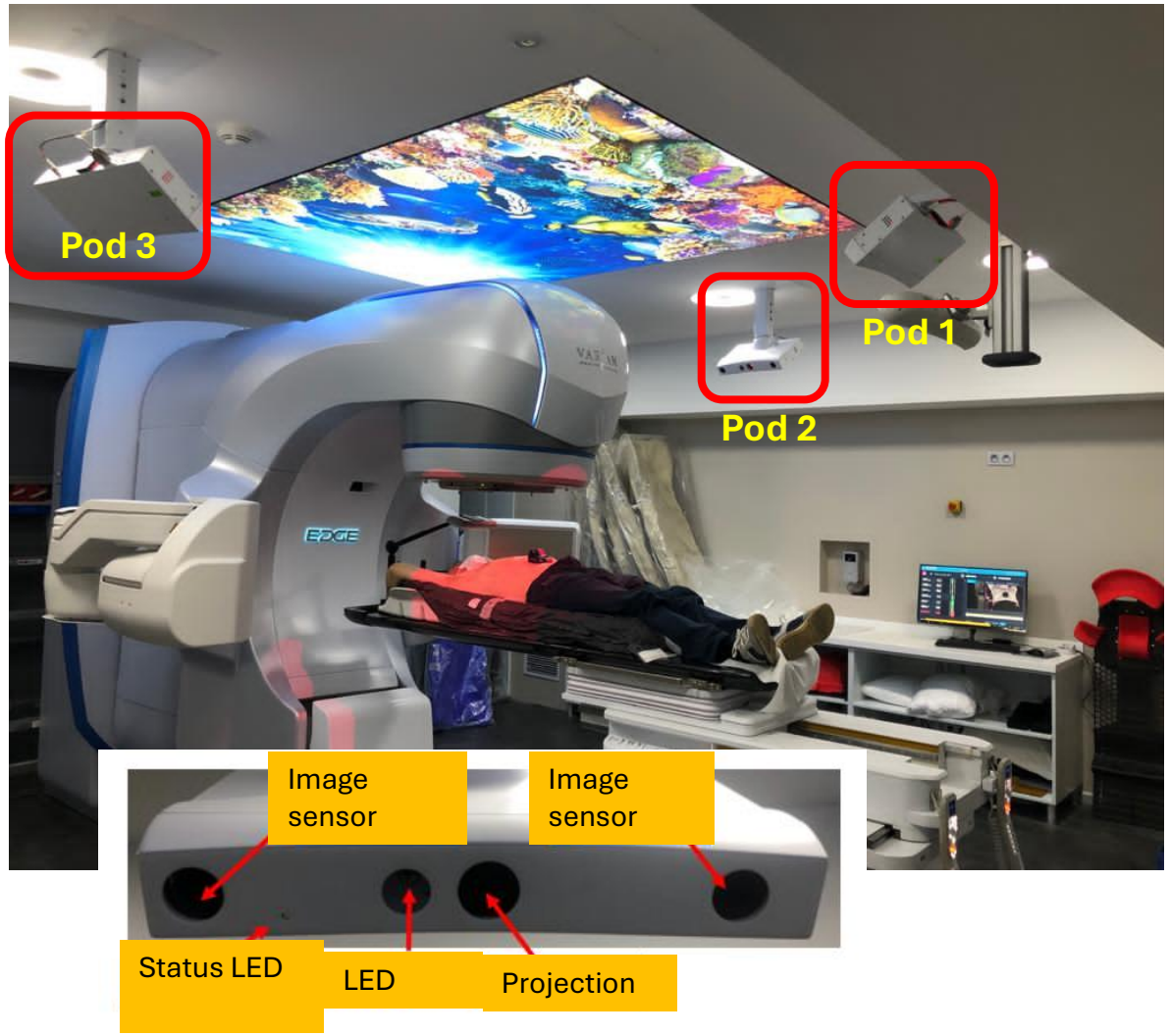
Camera pods (3)

Calibration plate

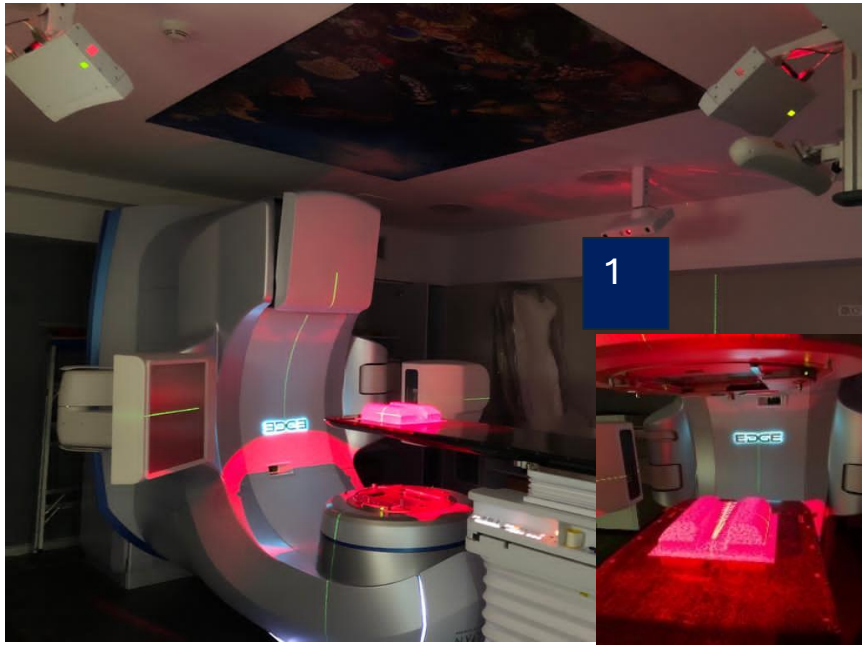
In treatment room

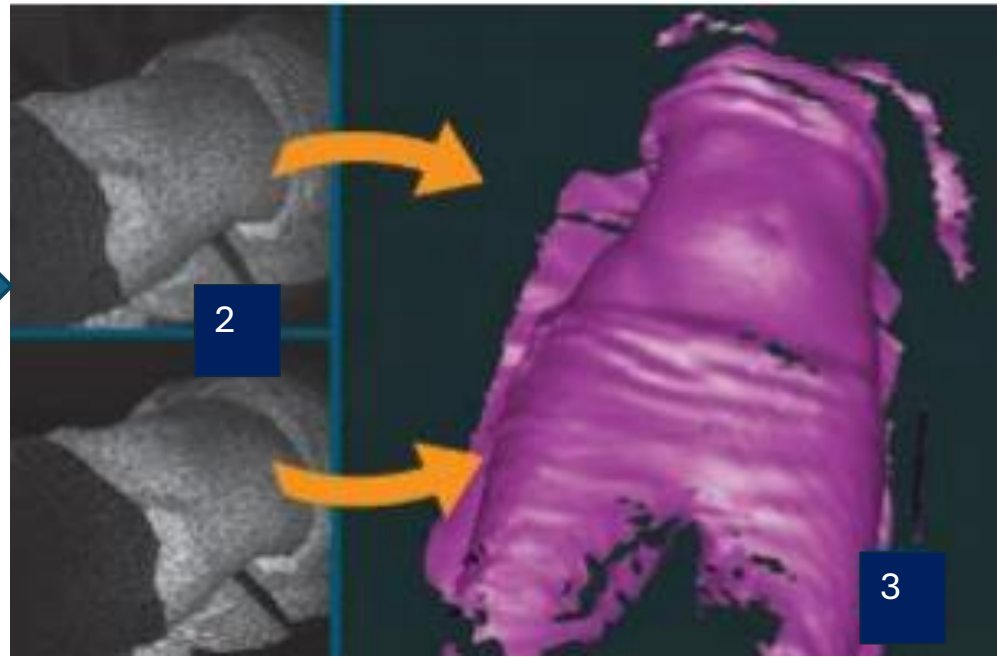
TREATMENT ROOM

- 3 ceiling mounted camera pods
- Each pod contains two camera sensors and a projector enabling real time 3D surface reconstruction
- The live surface is registered to a reference surface generating 6D shift information (real time deltas)



TREATMENT ROOM





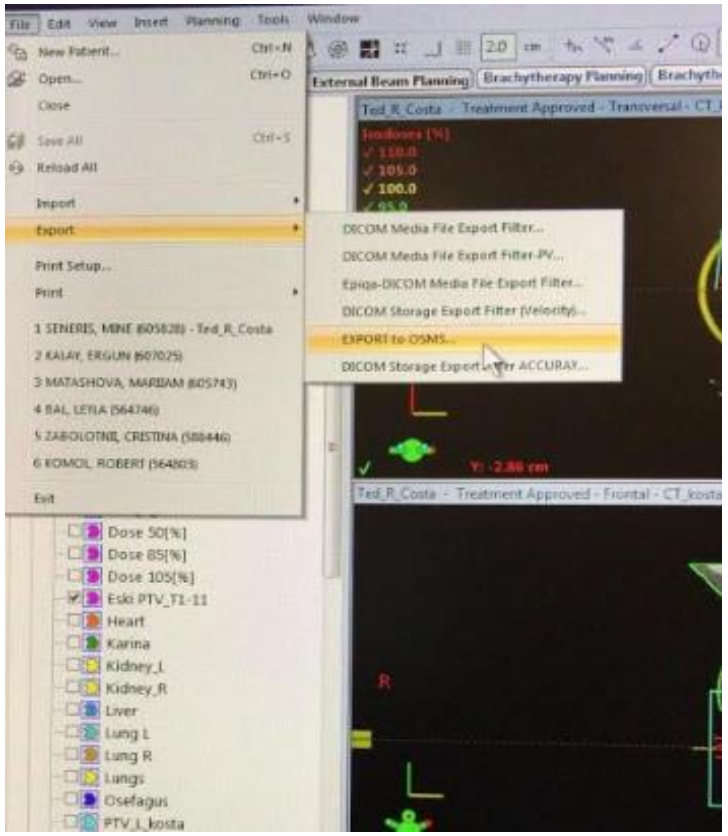
- 3 pods project a speckled red-light pattern onto patient's surface
- Stereo camera pods image pattern in 3D and software reconstructs full surface
- Surface matched in real time to reference image (from CT or AlignRT)

WORKFLOW – ROI

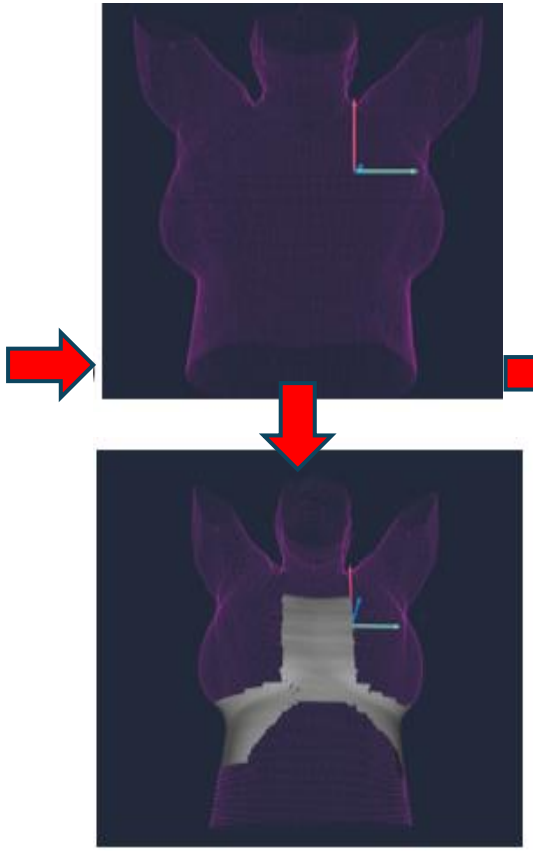
- Although the entire reference surface is displayed, only the selected ROI is used for fusion.

- In some cases, 2 different ROIs can be used for the same patient

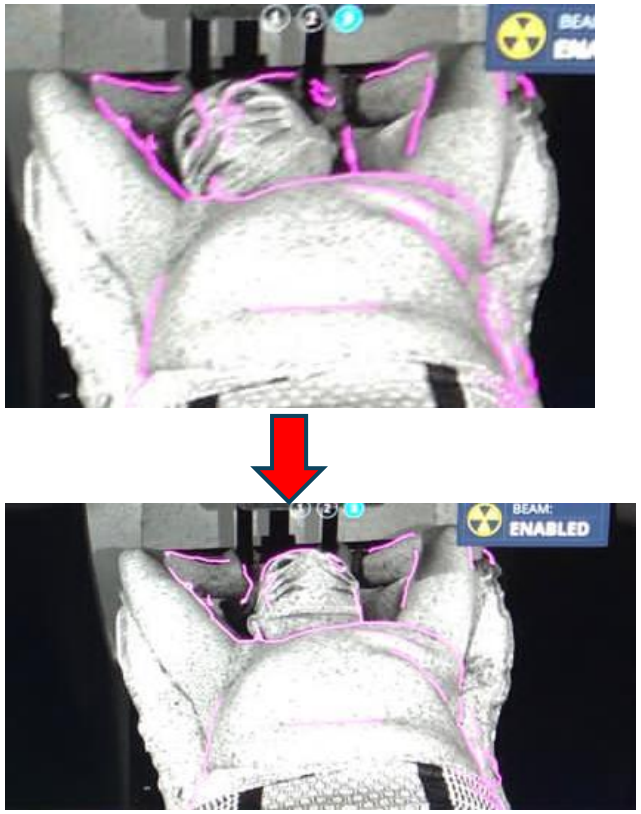
WORKFLOW



- Structure (Body)
- Plan (Isocenter)

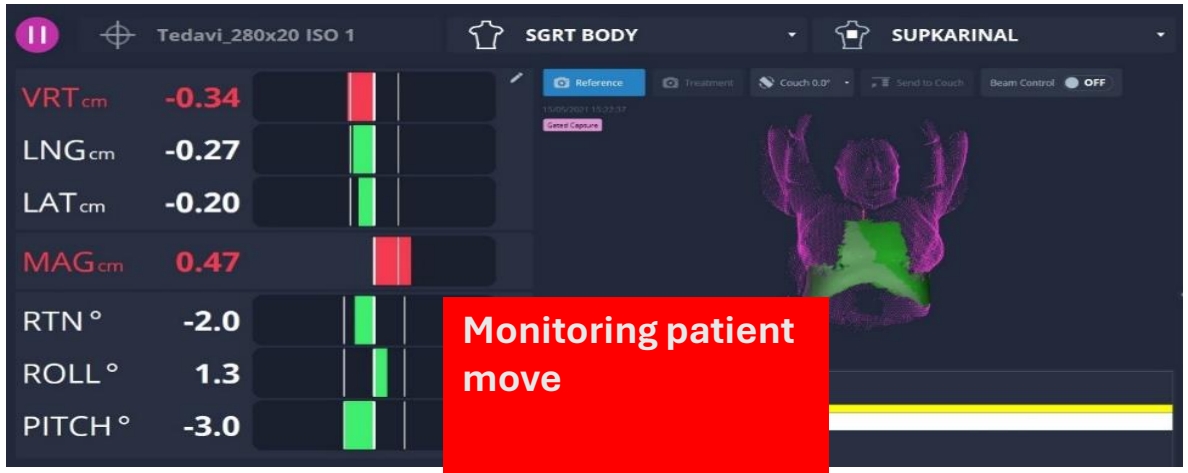


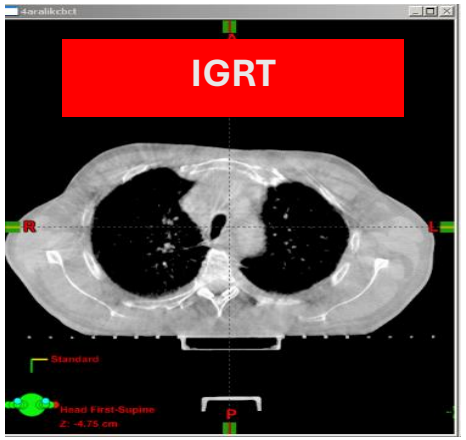
- Ref. Surface
- ROI (fusion)



Postural video for setup

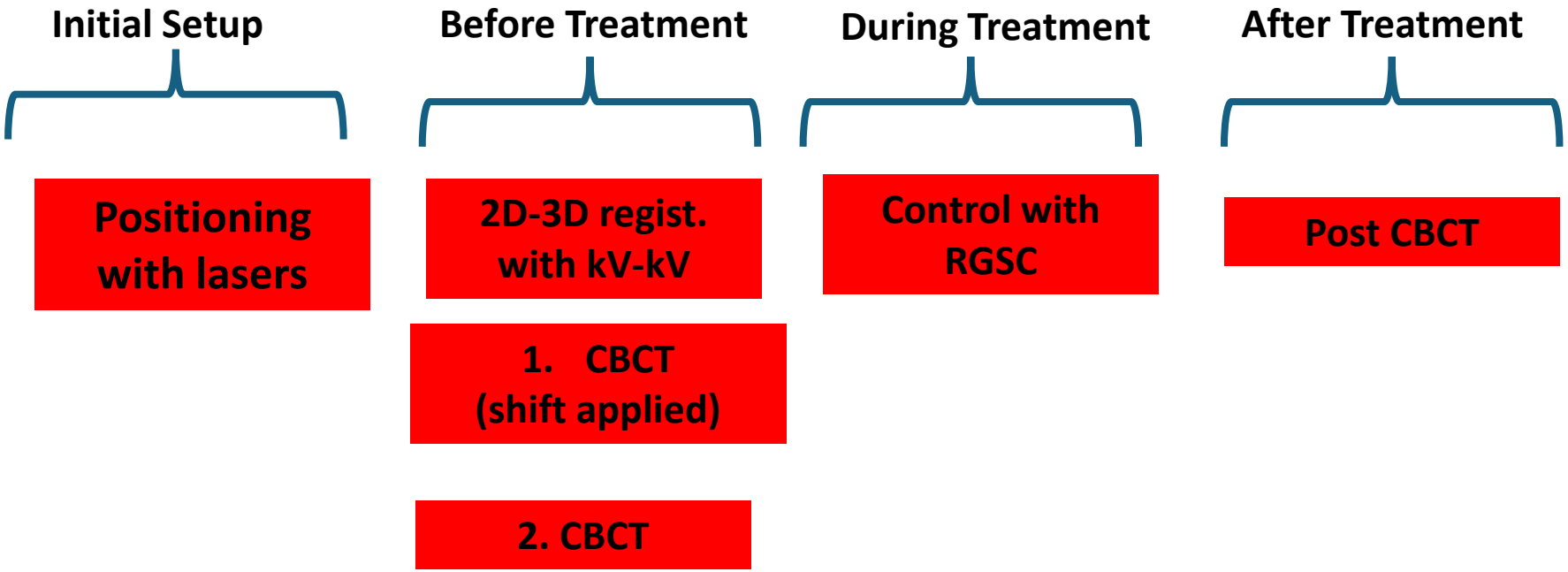
WORKFLOW


Tedavi_280x20 ISO 1
SGRT BODY
SUPKARINAL
VRT cm -0.34
LNG cm -0.27
LAT cm -0.20
MAG cm 0.47
RTN ° -2.0
ROLL ° 1.3
PITCH ° -3.0
Reference
Treatment
Couch 0.0°
Send to Couch
Beam Control OFF
Monitoring patient move

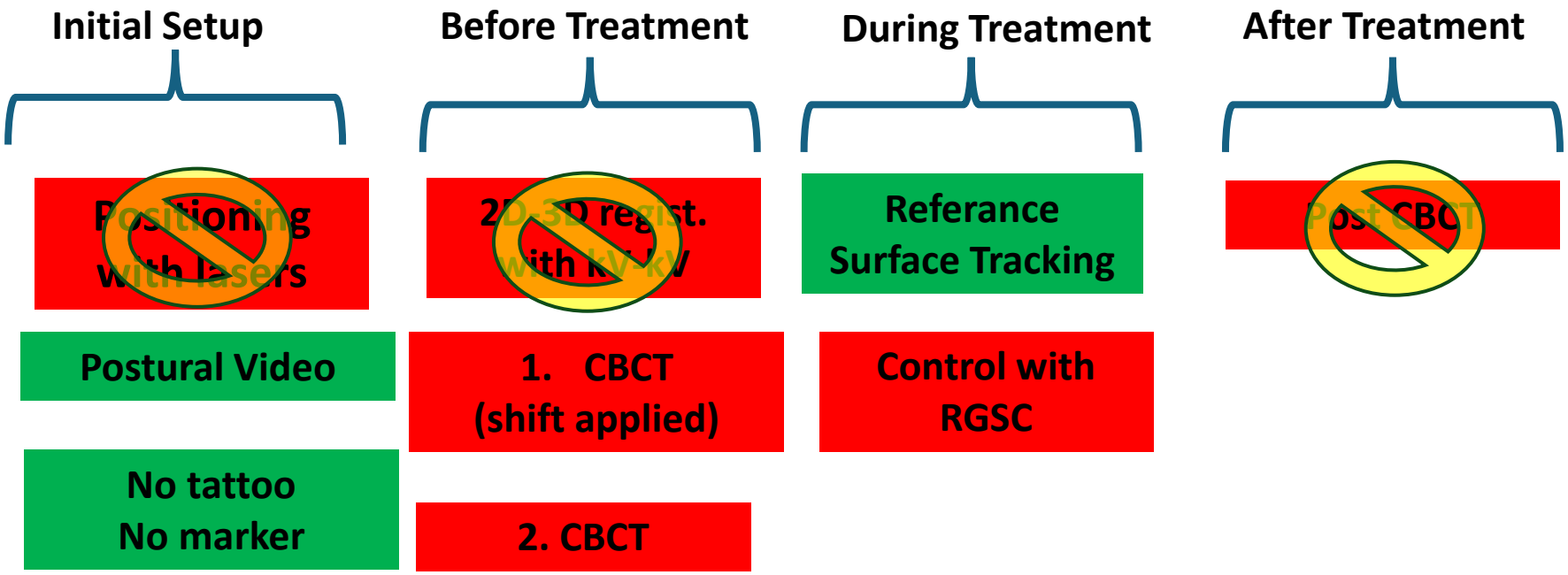

IGRT

VRT mm -0.2
LNG mm -2.2
LAT mm 1.3
MAG mm 2.5
RTN ° 0.6
ROLL ° 0.1
PITCH ° -0.6
Reference
Treatment
Couch 0.0°
Send to Couch
Beam Control OFF
Treatment

BEFORE VISION RT-LUNG SBRT



AFTER VISION RT-LUNG SBRT

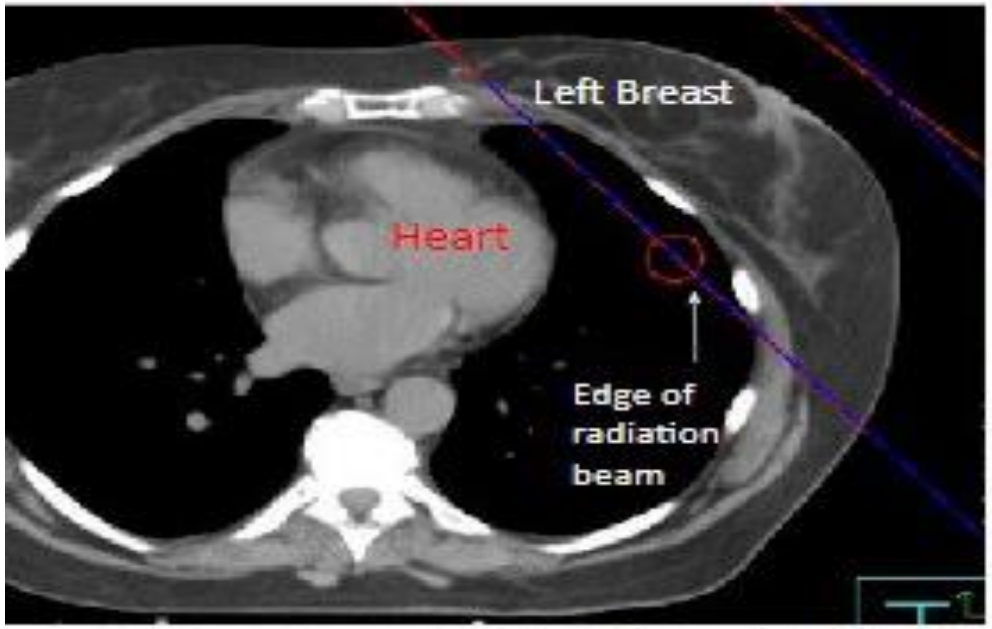


CASES THAT ILLUSTRATE the CLINICAL UTILITY of VISION RT SYSTEM

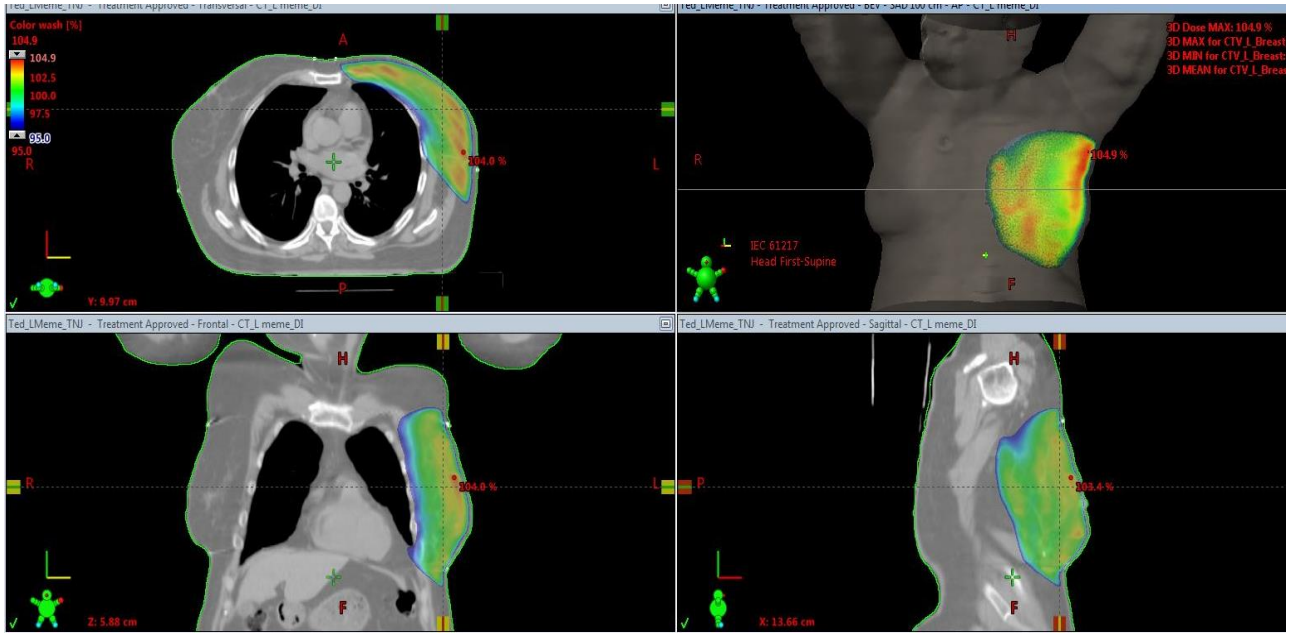
- SRS-SBRT patients
  - Lung
  - Brain
  - Adrenal
  - Spine
  - Liver
  - Prostate
  - Pancreatic tm
- Conventional Treatments
  - Left Breast
  - Thoracic
  - Extremity sarcoma

>2000 patients so far

CASE EXAMPLES – BREAST

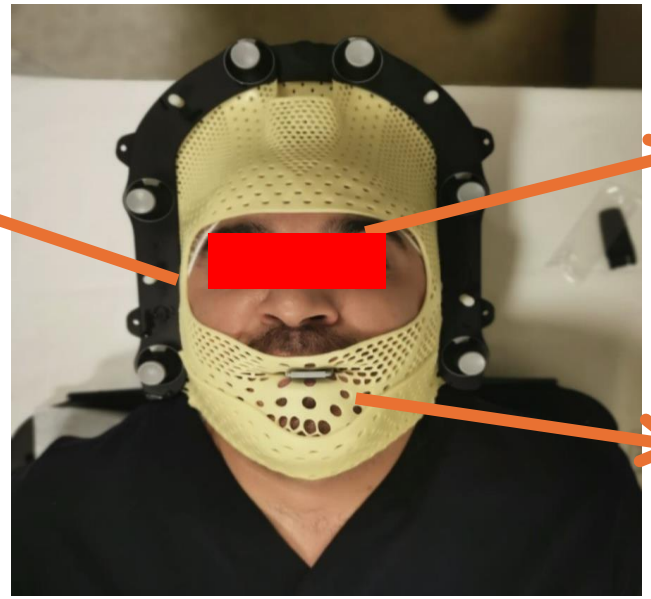


Deep Inspiration Breath Hold



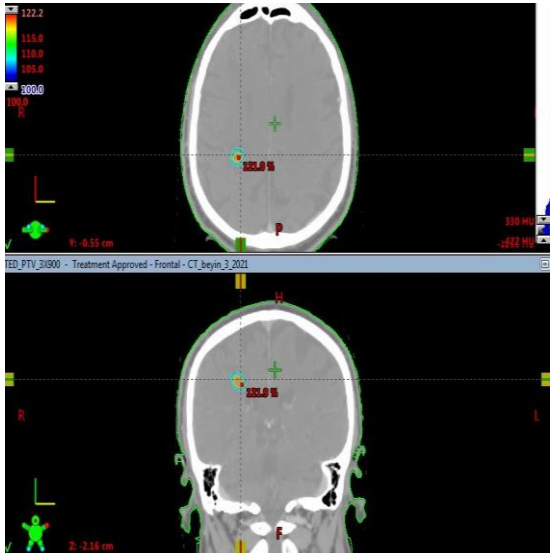
CASE EXAMPLES – BRAIN

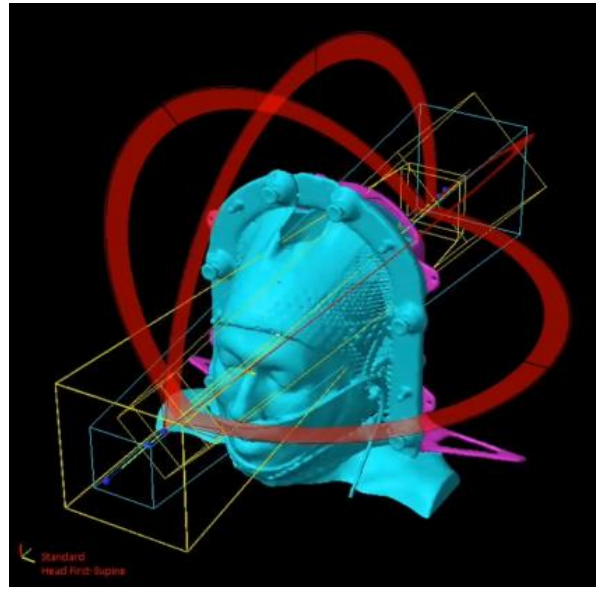
Open lateral surface



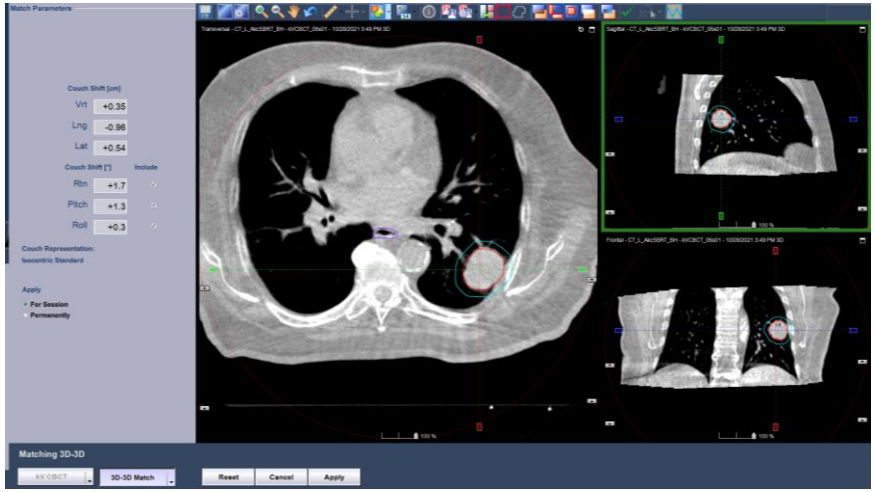
At least 2 cm space from eyebrow

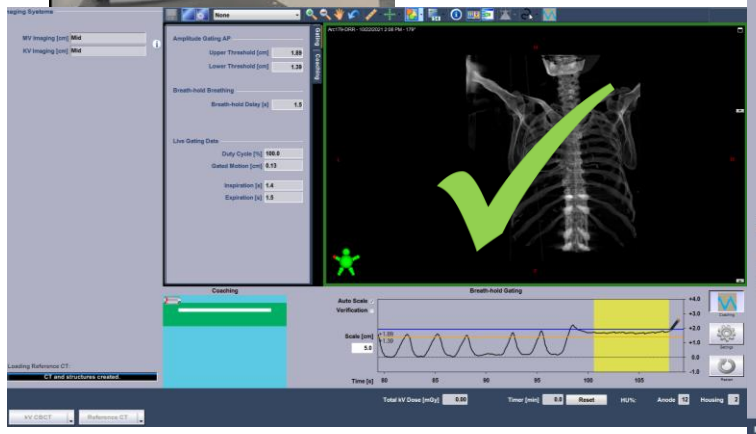
Rigid chin position

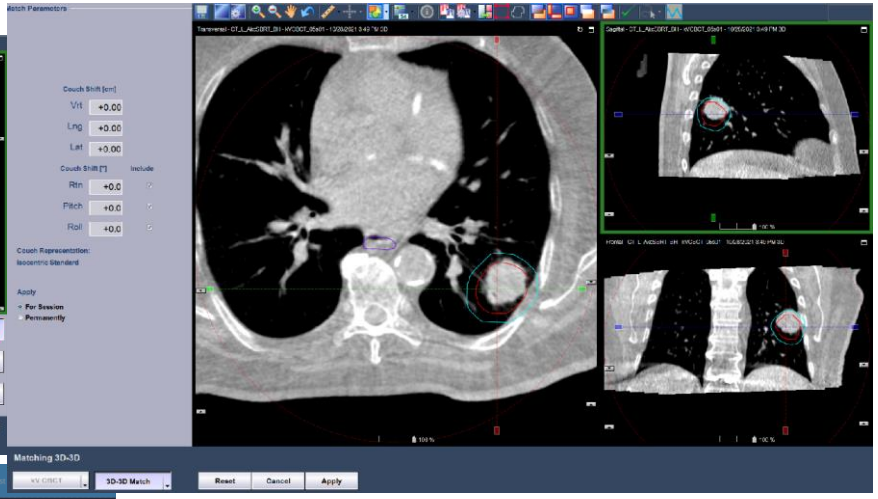


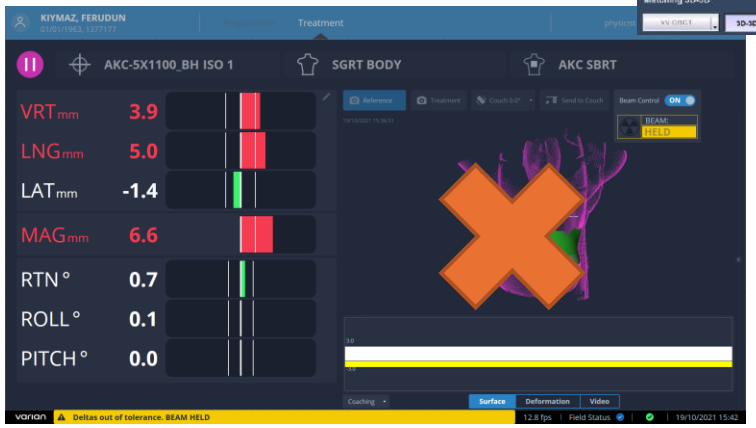


CASE EXAMPLES – LUNG









FEASIBILITY in LIVER SBRT

- Liver metastases from different primaries
- PROMs
- Two-step questionnaire

Technical Innovations & Patient Support in Radiation Oncology 28 (2023) 100223

Contents lists available at ScienceDirect

Technical Innovations & Patient Support in Radiation Oncology

journal homepage: www.sciencedirect.com/journal/technical-innovations-and-patient-support-in-radiation-oncology

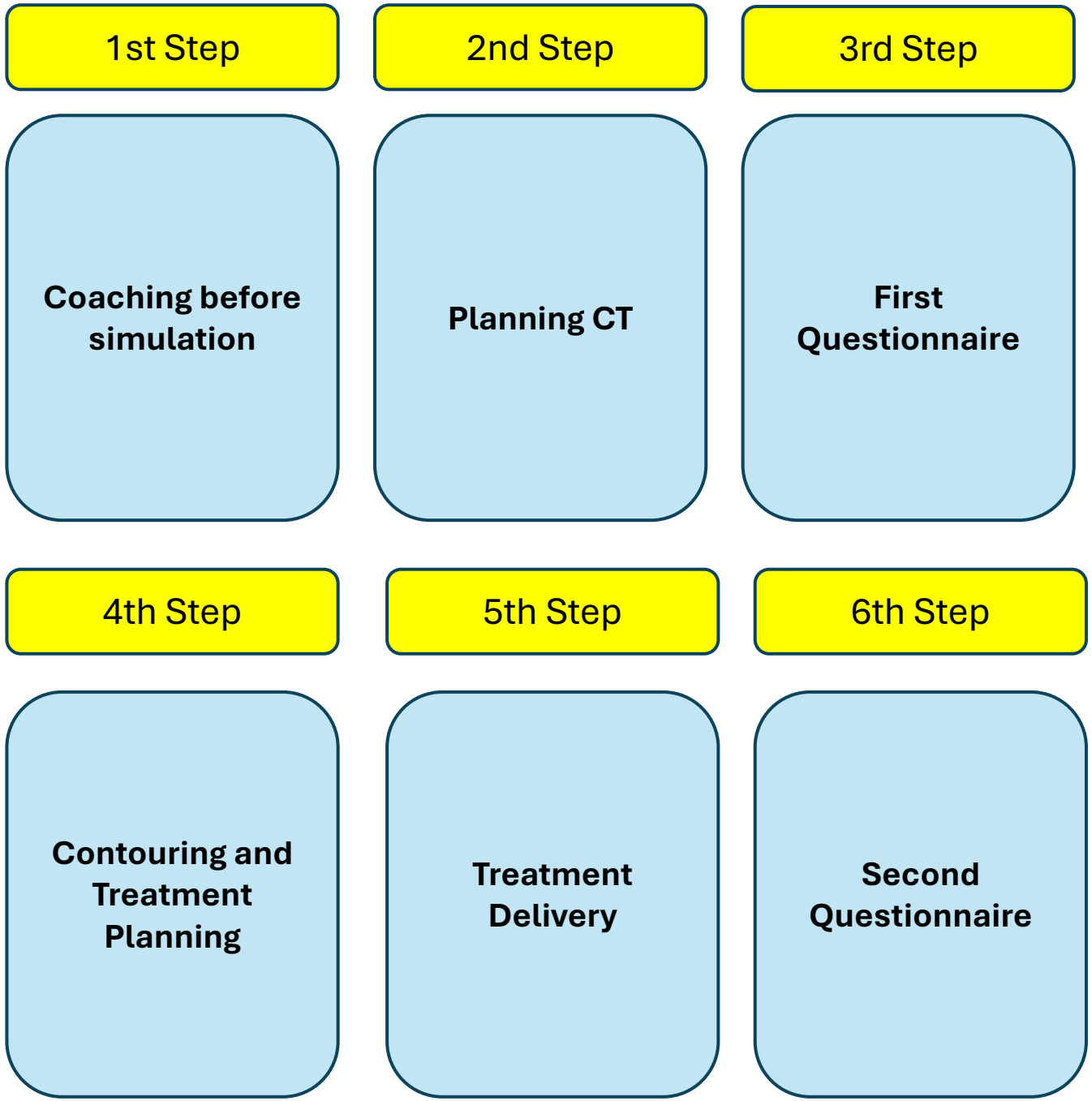
Feasibility and tolerability of breath-hold in liver stereotactic body radiotherapy with surface guided radiotherapy

Menekse Turna *, Esra Küçükmorkoç, Rashad Rzazade, Mehmet Doğu Canoğlu, Nadir Küçük, Hale Basak Caglar

Anadolu Medical Center, Department of Radiation Oncology, Gebze, Kocaeli, Turkey

First questionnaire (Before planning CT)
1. Did you find the training you received before the breath-hold procedure helpful?
2. Was the equipment used during breath-hold clear and understandable?
3. Were the commands given by the technician understandable during breath-hold?
4. Was it challenging to hold your breath?
5. Was the CT scan time long?
6. Did you experience stress during the CT scan?
7. Were you worried because you took an active role in the CT scan?
Second questionnaire (After completion of Treatment)
1. Did you find the training you received before the breath-hold procedure helpful?
2. Was the equipment used during breath-hold clear and understandable?
3. Were the commands given by the technician understandable during breath-hold?
4. Was it challenging to hold your breath?
5. Was the treatment period long?
6. Did you experience stress during the treatment?
7. Were you worried because you took an active role in the treatment?

STUDY WORKFLOW



FEASIBILITY in LIVER SBRT

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Feasibility and tolerability of breath-hold in liver stereotactic body

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First questionnaire (Before planning CT)	1-4 scale
1. Did you find the training you received before the breath-hold procedure helpful?	4
2. Was the equipment used during breath-hold clear and understandable?	3,9
3. Were the commands given by the technician understandable during breath-hold?	3,8
4. Was it challenging to hold your breath?	1,5
5. Was the CT scan time long?	1,1
6. Did you experience stress during the CT scan?	1,2
7. Were you worried because you took an active role in the CT scan?	1,2
Second questionnaire (After completion of Treatment)	**1-4 scale**
1. Did you find the training you received before the breath-hold procedure helpful?	4
2. Was the equipment used during breath-hold clear and understandable?	3,9
3. Were the commands given by the technician understandable during breath-hold?	3,9
4. Was it challenging to hold your breath?	1,6
5. Was the treatment period long?	1,4
6. Did you experience stress during the treatment?	1,5
7. Were you worried because you took an active role in the treatment?	1,2

SUMMARY…

- More precise radiation therapy allows better control
- Less toxicity
- Good plans are essential
- IGRT is essential
- Set-up
- In room imaging
- Motion
- Gating
- SGRT provides more confidence in so many subtitles

VİZYONUMUZ
ANADOLU H
MİSYONUMUZ