Cleveland Clinic

VMAT TBI at Cleveland Clinic

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Cleveland Clinic Foundation

VMAT-TBI at Cleveland Clinic

No Conflict of Interest

Background

- VMAT-TBI program
  - To replace the classic whole body field-technique for full dose TBI
  - 26 patients (4 pediatric patients) 6/2020-5/2021

- Why VMAT-TBI
  - Patient comfort
  - Better control of dose distribution
  - IGRT capability

Sim-to-Tx workflow

- Equipment
  - Philips Big Bore CT
  - Varian Truebeam Linac
  - Pinnacle TPS (v16.2)
  - MIM, Mosaiq
  - Immobilization devices
    - Full body vacuum bag
    - Head plate and 3 point (open face) mask

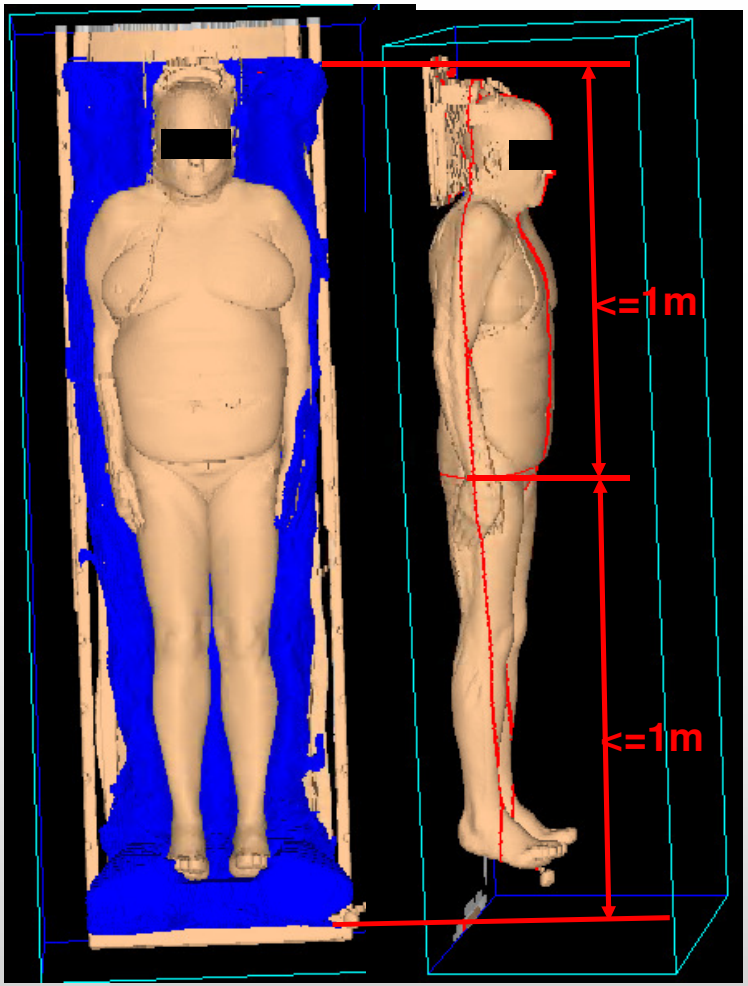
Sim-to-Tx workflow

- Equipment limitations (for TBI)
  - CT scan length Limit (125cm)
    - Scan in head-first supine (HFS) and feet-first supine (FFS) directions
  - Linac table travel Limit (110cm)
    - Treat in HFS and FFS directions
  - Field size & MLC travel distance limitations
    - Multi-isocentic VMAT

Sim-to-Tx workflow

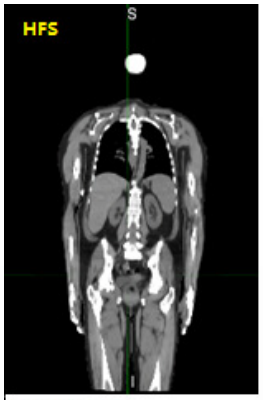
- Patient Setup
  - Supine, 3 point open face mask, arms by body side, legs straight

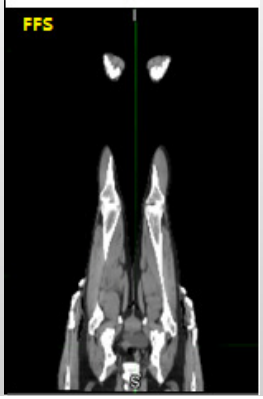
- CT Scan
  - Body protocol w 5mm slice thickness and extended FOV
  - HFS CT: Top of head to below pelvis
  - FFS CT: bottom of feet to above pelvis
  - Mark laser origin point in the pelvis
    - <=1 m to each end for Linac clearance
    - Reference point for setup in HFS and FFS directions



Sim-to-Tx workflow

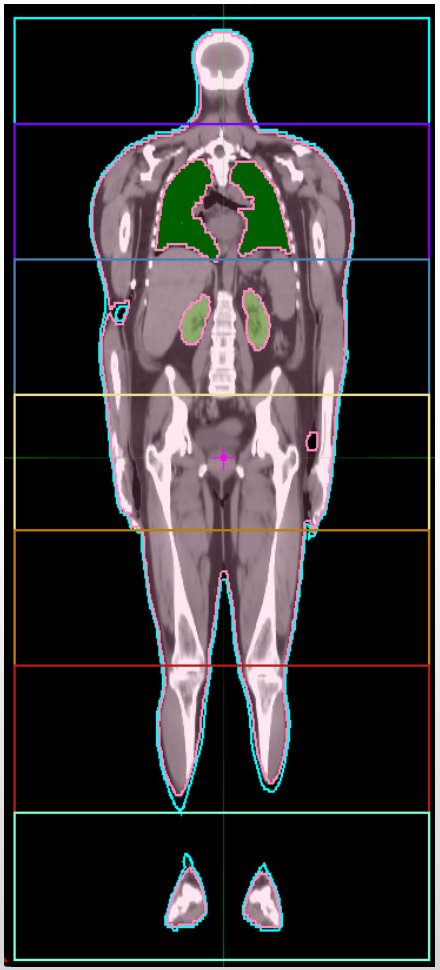
- Image processing
  - Create whole-body (HFS) CT
    - Stitch the HFS CT and FFS CT using a MIM workflow
    - Registration in the pelvis
    - Used to
      - Create a whole body VMAT TBI plan
      - Export beams to be delivered in HFS direction
  - Create whole body FFS CT
    - Rotate CT and correct patient orientation Dicom label using MIM tools
    - Used to
      - Export beams to be delivered in FFS direction





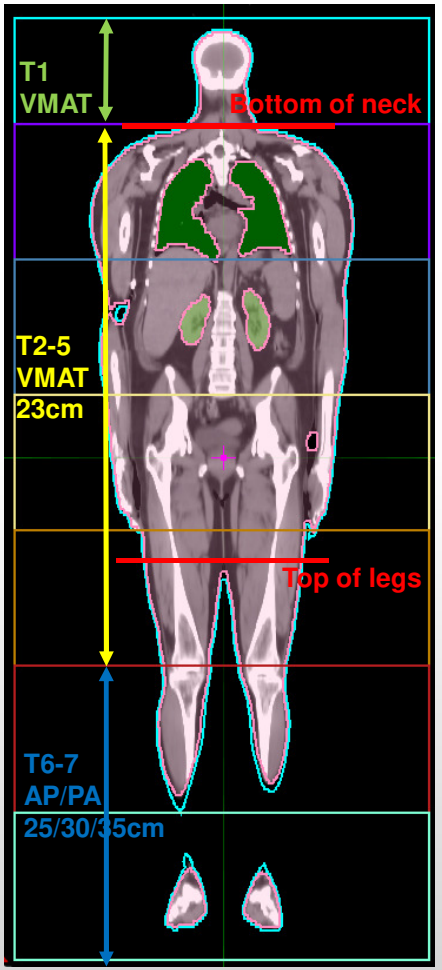
Sim-to-Tx workflow

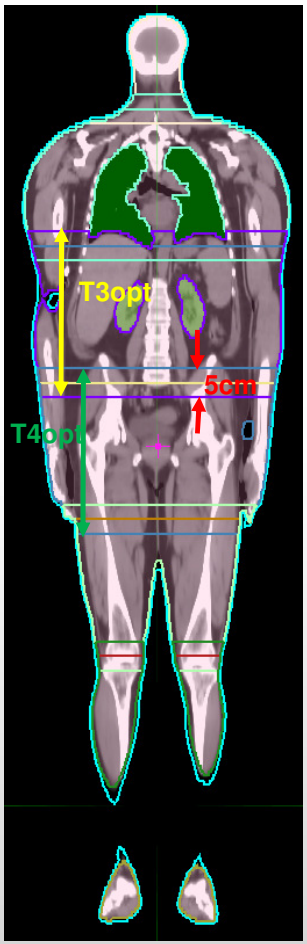
- Regions of interest (ROIs)
  - Lungs and kidneys
    - Atlas based auto-segmentation
  - PTV and sub-targets
    - Auto segmentation using a MIM workflow
    - PTV=body contracted 5mm (3mm each direction) – lungs and kidneys
    - Divide into multiple sub-targets



Sim-to-Tx workflow

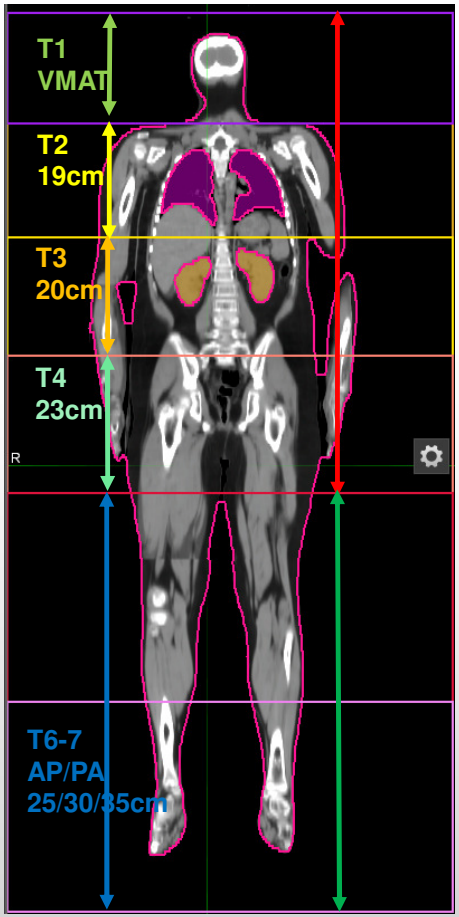
- ROIs
  - Sub-targets
    - Specify bottom of neck and top of legs
      - VMAT: from head to top of legs
      - AP/PA: rest of the body (legs and feet)
    - PTV divided into sub-targets T1-Tn
      - T1 head and neck
      - Other VMAT sub-targets 23cm in length
      - A look up table to determine AP/PA sub-target length (25, 30, or 35cm)
      - n=6-8
    - Expands Tx (x=1:n) 2.5cm in sup & inf directions
      - 5cm target feathering zone





Sim-to-Tx workflow

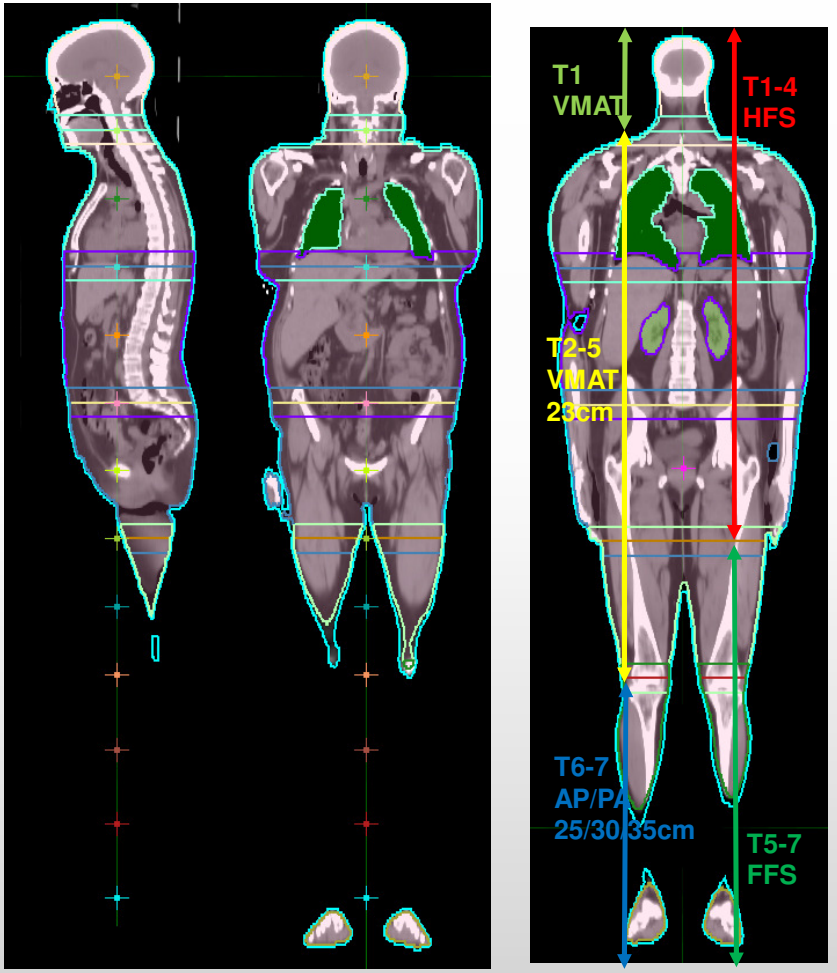
- ROIs
  - Sub-targets
    - Pediatric patients
      - Reduce VMAT sub-target length to place junction between lungs and kidneys
    - Large-sized patients (width > 50cm)
      - Reduce VMAT sub-target length to cover arms
      - 5cm increase in patient width -> reduce VMAT sub-target length by 1 cm



Sim-to-Tx workflow

- Points of interest (POIs)
  - Isocenters and junction points
    - Same Vrt and Lat, only Long shift

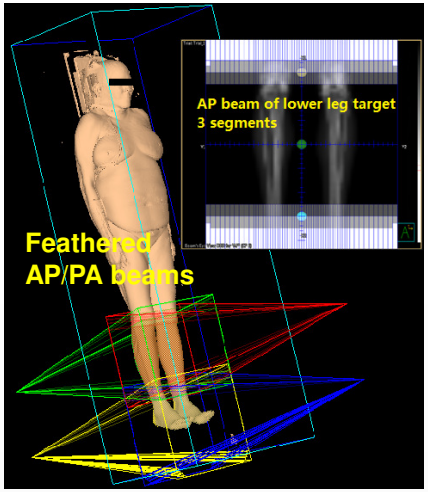
- Sub-targets/isocenters
  - By beam type
    - VMAT sub-target
    - AP/PA sub-target
  - By treatment orientation
    - HFS sub-targets: iso sup to laser origin
    - FFS sub-targets: iso inf to laser origin

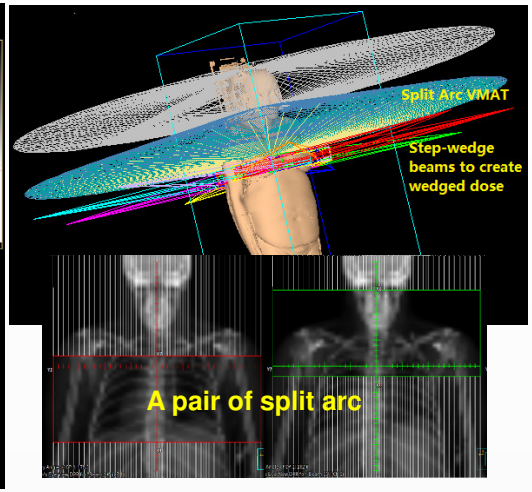


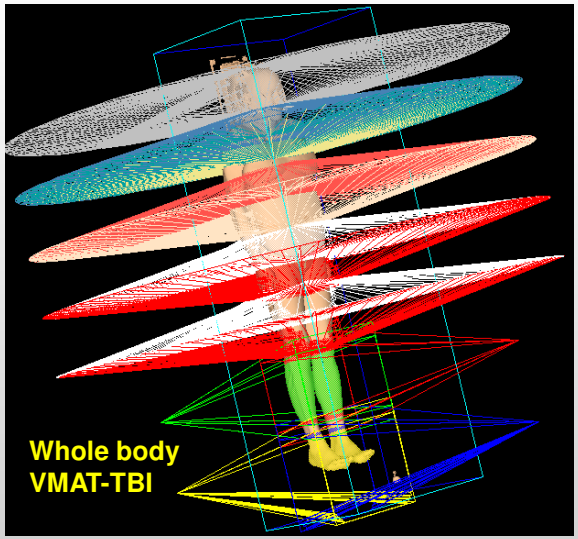
Sim-to-Tx workflow

- Whole body VMAT-TBI plan
  - 6X, collimator 90 degree
  - Feathered AP/PA beams for legs/feet
  - Sequentially optimize VMAT sub-targets
    - Split arc technique
    - Wedged dose at the junction as base dose
  - 200 MU/min at lung

- Planning Objectives
  - Prescription:
    - 1.65 Gy/Fx x 8 or 1.5 Gy/Fx x 8
  - Optimization
    - PTV V95>95%
    - PTV V110 ALARA
    - Mean lung dose < 10Gy (adult) or 8Gy (pediatric)
    - Mean kidney dose < 6Gy

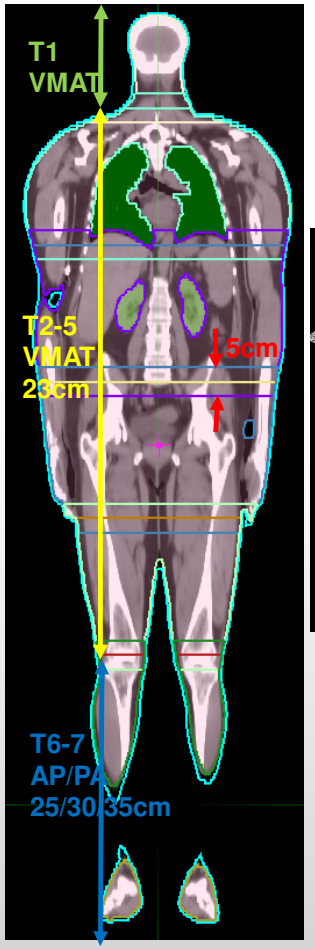


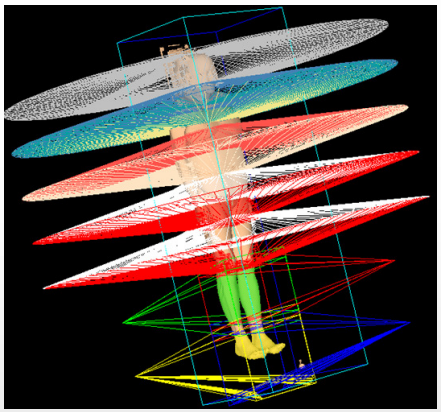




Sim-to-Tx workflow

- Sub-targets
  - Why 23cm length for VMAT sub-targets?
    - Plan quality best when beam width <14.5cm x 2
      - Set 28cm length for (sub-target + target feathering zone) = set 23cm length for sub-target
    - Anatomically separates body into thorax, abdomen and pelvis
  - Why target feathering zone
    - To improve delivery robustness to set up uncertainties

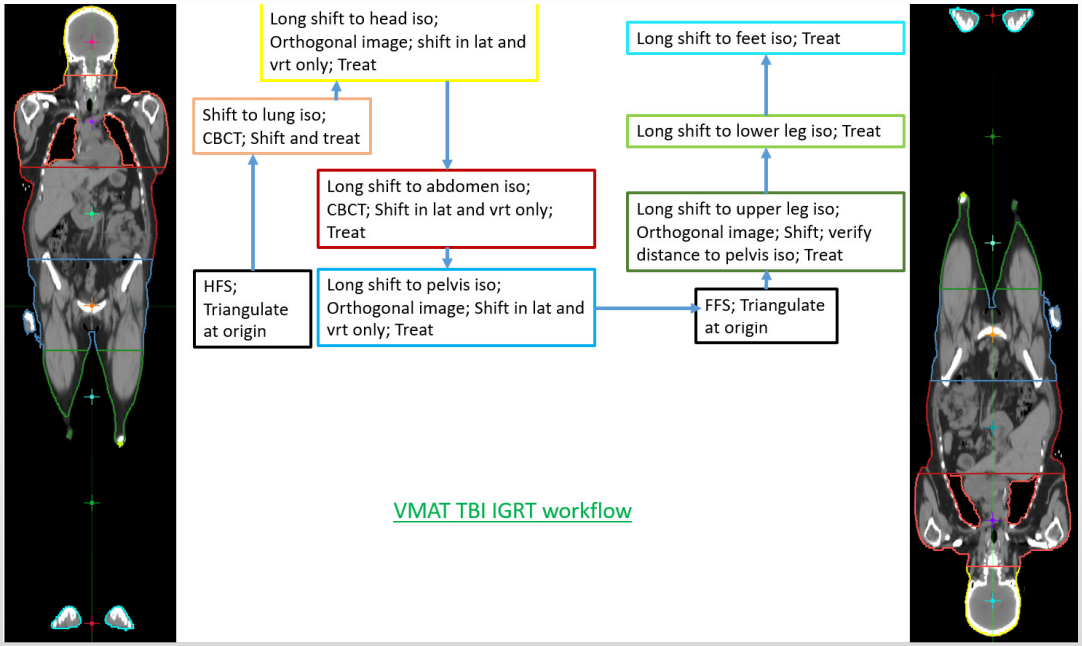




Sim-to-Tx workflow

- Plan export
  - Split the whole body VMAT-TBI plan into
    - HFS plan: beams with isocenter sup to laser origin
    - FFS plan: beams with isocenter inf to laser origin
      - From whole-body plan to FFS: use pinnacle script to rotate collimator angle 180 degrees and mirror gantry angle L/R for all control points

- IGRT workflow
  - Imaging every fraction



Sim-to-Tx workflow

- Time:
  - CT Simulation: 1 hr
  - Image processing, critical structures, PTV and sub-targets, and isocenters: 10 min
  - Planning: 1 day
  - Plan export: 3-4 hours
  - QA, (physics and therapy) chart checks: 2-3 hrs
  - Treatment delivery: 1 hr / fx

Summary

- VMAT-TBI at Cleveland Clinic
  - Hybrid VMAT
  - Create the whole-body CT by registering the head-first CT and the feet-first CT
  - Divide the whole body into sub-targets for planning
    - Optimal sub-target division depends on patient anatomy and TPS/Linac
    - Target feathering zone to improve plan robustness to setup uncertainties
  - IGRT to improve delivery accuracy
  - Automatic scripts to improve efficiency


Thank you
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