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JOINT AAPM | COMP MEETING

Feasibility of Adaptive Replanning with HyperSight-CBCT on a C-arm Linac

Juan Chen,[1] Kai Wang,[1] Amit Sawant,[2] Shifeng Chen,[2] Jason K Molitoris,[2] and Jochen Cammin[2]

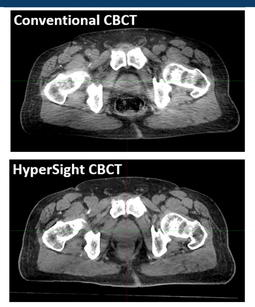
(1) Department of Radiation Oncology, University of Maryland Medical Center, Baltimore, MD,
(2) Department of Radiation Oncology, University of Maryland School of Medicine, Baltimore, MD

ABSTRACT

Cone beam CT (CBCT) is used for position verification, monitoring anatomical change, dose calculation, and adaptive radiotherapy. But conventional CBCT has well-known limitations: cone beam artifacts, slow acquisition leading to motion blur, HU inaccuracy, metal artifacts, and limited field of view (FOV).

HyperSight (HS) CBCT on TrueBeam is designed to address these issues. In this work, we evaluated HyperSight's clinical feasibility for adaptive replanning by examining FOV adequacy, image quality for routine target/OAR contouring, and dose calculation accuracy from patient data.

1. BACKGROUND



HS CBCT vs conventional CBCT

- Improved HU accuracy
- Better soft tissue contrast
- 50% faster acquisition
- Larger imaging volume
- Metal artifact reduction

2. METHODS

40
Patients enrolled and treated on IRB-approved protocol

2
HS-CBCT scans/patient
One at beginning
One at mid-course

Sites (n)
Pelvis (18)
HN (8)
Breast (8)
Lung (8)
Abdomen (6)

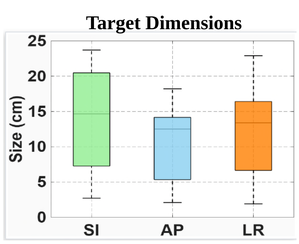
Three analyses

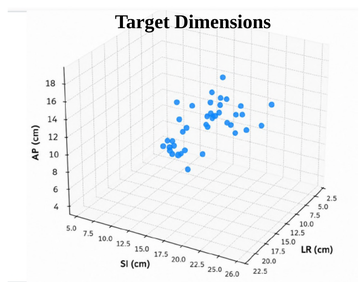
1	Volume coverage	Do targets/OARs fit within the HS-CBCT imaging volume?
2	Image quality	Is HS-CBCT sufficient for target and OAR contouring?
3	Dose accuracy	How accurate is dose calculation on HS-CBCT?

3. RESULT: FIELD-OF-VIEW COVERAGE

HS-CBCT range
48.5 cm Ø × 25.1 cm
vs. conventional CBCT
46.5 cm Ø × 17.7 cm

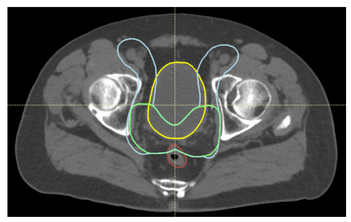
100%
Targets and OARs in FOV across all 40 patients





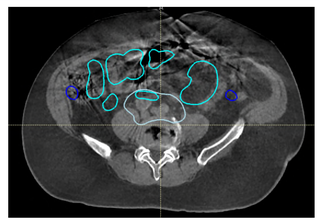
- 25% of targets and 2.5% of OARs had <2 cm margin to the superior/inferior CBCT boundary
- Largest targets were pelvis cases with nodal involvement, exactly where the extended range matters most.

4. RESULT: IMAGE QUALITY



High image quality when no motion present clear OAR/target delineation

92.5%
Assessed as sufficient for target contouring

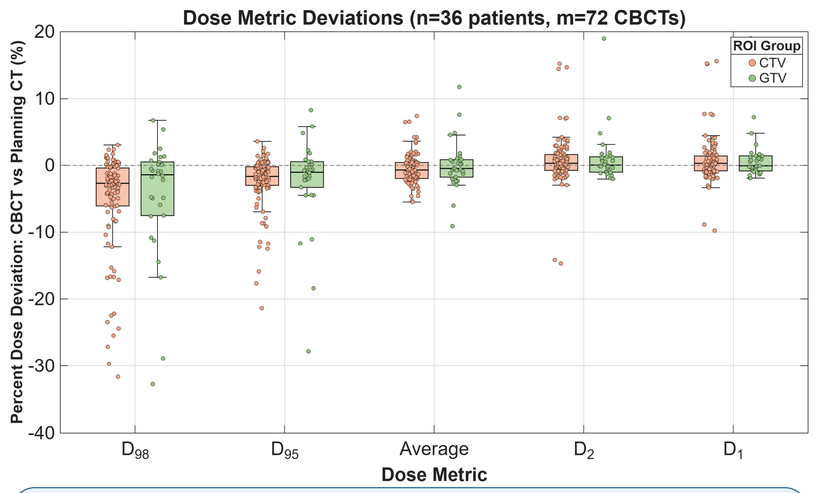


Peristalsis/respiration remain the key limiting factors

87.5%
Assessed as sufficient for OAR contouring

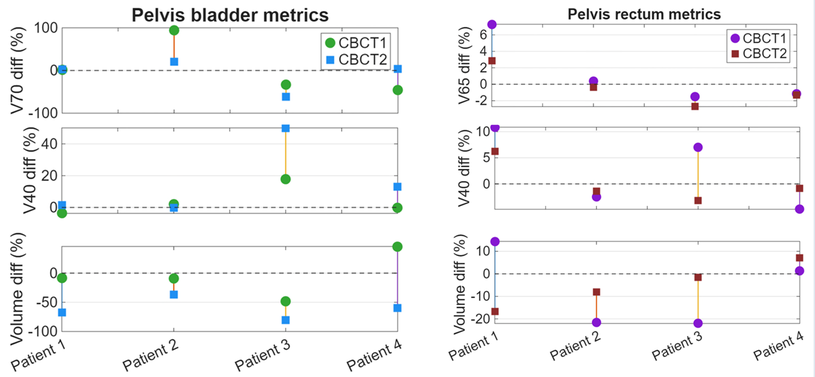
5. DOSE ACCURACY: TARGET DOSE

Note:1) Physicians contoured targets and critical OARs on HS-CBCT.
2) No deformable image registration was done to account for anatomy changes.
3) The clinical plan was recalculated on the HS-CBCT with appropriate electron-density calibration curve.

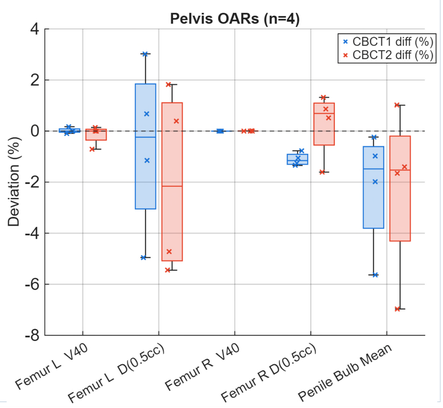


HS CBCT dose recalculation showed good agreement with planning CT for CTV/GTV average and high-dose metrics, while low-dose coverage metrics such as D98 and D95 were more variable and showed occasional undercoverage due to physician's contouring habit or geometry change.

6. DOSE ACCURACY: SITE-SPECIFIC OAR FINDINGS



- Femoral heads and penile bulb showed good agreement between HS CBCT and CT.
- Bladder dose increased if the bladder volume was smaller compared to the planning CT.
- Rectum volume and dose metrics were less sensitive than bladder.
- Variation is driven by inter-fractional filling.



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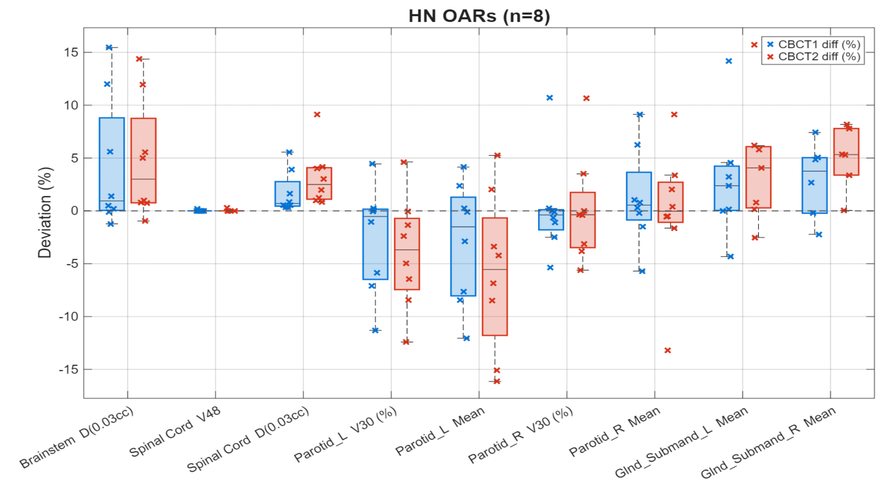
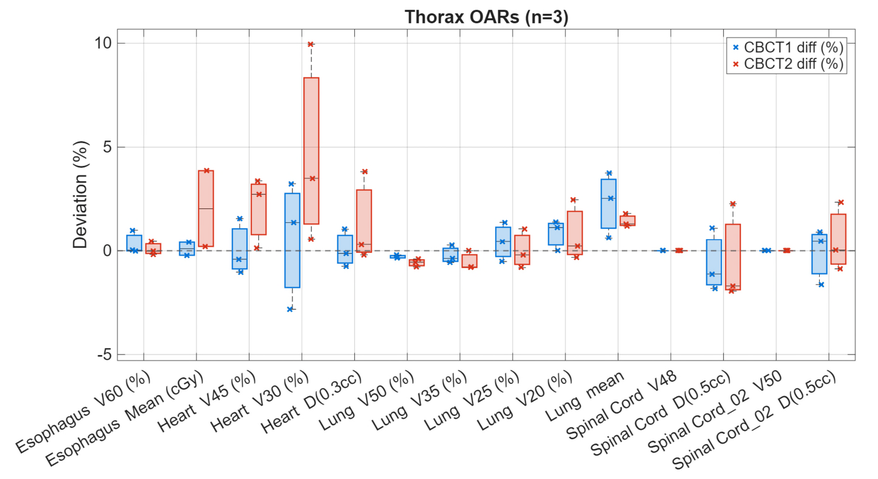


Stable structures
- Spinal cord and brainstem stayed close to planning CT.
- Median OAR deviation < 5% across detailed subsets.

Variable structures
- Parotid and submandibular doses showed the largest deviations.
- Driven by inter-fractional weight loss and physician's contouring habit.



Stable structures
- Lung and spinal-cord metrics stayed close to planning CT.
- Median OAR deviation < 5% across detailed subsets.

Variable structures
- Esophagus and heart showed the largest deviations.
- A consequence of organ positional changes / respiratory motion.

7. CONCLUSIONS and NEXT STEP

- ✓ HS-CBCT on TrueBeam has improved soft-tissue contrast, HU accuracy, and a larger FOV compared to conventional CBCT.
- ✓ The majority of HS-CBCTs resulted in adequate volume coverage and image quality for targets and OAR contouring. Respiratory and peristaltic motion is a limiting factor for IQ.
- ✓ Dose recalculation was generally within a few percentage points of planning CT, with site-specific sensitivity to motion, filling, and contouring.

Clinical significance: This work offers practical data on HS-CBCT that can help guide broader clinical implementation and future use for adaptive workflows on a C-arm linac, such as contouring and dose calculation directly on HS-CBCT.

➡ **Next step: Complete all OAR analyses**

DISCLOSURE
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No conflicts of interest reported.

CONTACT
Juan Chen, PhD
juan.chen@umm.edu

Jochen Cammin, PhD
Jochen.Cammin@umm.edu