Replacing Re-Simulation CT Using Extended–Field-of-View Hypersight CBCT In Gynecologic Cancer for Offline Adaptive Radiotherapy

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Introduction & Aim

- GYN cancer patients frequently experience significant weight loss and nodal volume changes during conventional pelvic radiotherapy, often necessitating CT re-simulation for treatment adaptation.
- HyperSight CBCT, available on TrueBeam Linac, provides a 70-cm extended FOV, improved Hounsfield unit accuracy, faster gantry rotation, and enhanced image quality compared with conventional CBCT.
- These capabilities enable direct **dose calculation** and **offline plan adaptation** on CBCT images, potentially eliminating the need for re-simulation CT.

This study evaluates the feasibility of HyperSight CBCT–based offline adaptive radiotherapy on standard Linac.

Method

- A dedicated CBCT imaging protocol was developed for large gynecologic patients (***Table 1***).
- Extended CBCT acquisitions were used for long targets, in which two CBCT scans were acquired and stitched together.
- External contour accuracy and HU fidelity for large anatomies were evaluated using a pelvic phantom. The phantom was shifted off-center to simulate different body sizes.
- Dose calculation accuracy on CBCT was evaluated against CT in five GYN patients. CBCT and CT images were rigidly registered, and clinical plans were recalculated on CBCT. DVH metrics were compared between doses calculated on CBCT and CT, and gamma pass rates were determined.

Table 1. CBCT scanning protocol. FOV diameter: 70 cm. FOV range: 25 cm. Fast Gantry: 1.5RPM. Frame Rate: 22 fps. Gantry Speed: 9 ˚/s. Fan type: half. Number of Projections: 884. Projection increment: 0.407 ˚. Acquisition time: 40 s. The Pelvis GU protocol is recommended for patients with a standard body habitus, while the Pelvis Large GU protocol is recommended for patients with a larger body habitus. For patients with metallic implants, MAR reconstruction is recommended. The Smooth reconstruction algorithm is recommended to reduce image noise and improve overall image quality.

IGRT Mode	X-ray Voltage (kV)	Current-time Product per Frame (mAs)	Current-time Product per Scan (mAs)	Reconstruction Parameters	Filter	Noise Suppression
Pelvis GU	125	1.2	1060.80	iCBCT	Standard	Medium
				iCBCT MAR	Sharp	Medium
				iCBCT Smooth	Smooth	Very High
				iCBCT MAR Smooth	Smooth	Very High
				iCBCT Sharp	Sharp	Very High
Pelvis Large GU	140	1.9	1679.60	iCBCT	Standard	Medium
				iCBCT MAR	Sharp	Medium
				iCBCT Smooth	Smooth	Very High
				iCBCT MAR Smooth	Smooth	Very High
				iCBCT Sharp	Sharp	Very High

Table 2. External contour accuracy and HU fidelity for large body size. Body size represents the largest body width in left-right direction. HU difference was calculated only on the truncation area. Dose difference was calculated based on point dose which is the Dmax.

Body size (cm)	33	43	45	47	49	51	53
HU difference (HU)	0	0	0	0	0	-334	-334
External difference (mm)	0	0	0	0	0	3.5	7.5
Dose difference	0	0	0	0	0	1.8%	1.8%

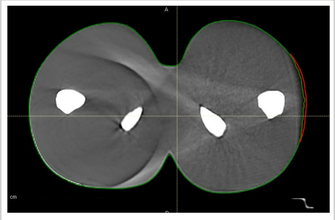

Figure 1. Axial truncation begins to appear at a body width of 51 cm.

Table 3. The difference of DVH metrics between dose calculated on CT and CBCT. Gamma pass rate was calculated with criteria of 2 mm/2% with 10% of threshold and global normalization.

	PTV V100%	PTV Dmax	CTV/GTV V100%	Gamma pass rate
Mean (min, max)	-0.52% (-2.08%, 0.82%)	0.80% (-0.70%, 2.30%)	-0.32% (-1.25%, 0.00%)	96.5% (93.0%, 99.0%)

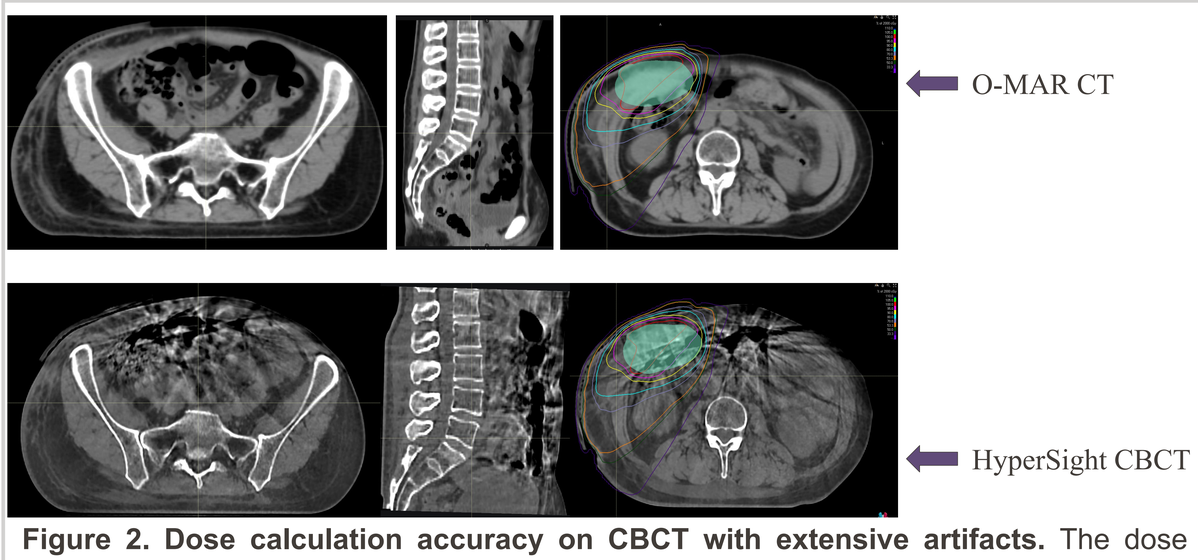

Figure 2. Dose calculation accuracy on CBCT with extensive artifacts. The dose distribution achieved a gamma pass rate of 95.1% using 2 mm/2% criteria.

Results

Extended CBCT acquisition should be used when the target length exceeds 20 cm in the superior–inferior direction. Extended CBCT can image up to 48 cm in the superior–inferior direction (***Figure 3***).

Figure 3. Non-extended CBCT and extended CBCT.

The pelvis phantom studies demonstrated that axial truncation begins to appear at a body width of 51 cm with 70-cm FOV reconstruction (***Figure 1***). Contour accuracy and HU fidelity results for different body sizes are summarized in ***Table 2***.

Differences in DVH metrics between doses calculated on CBCT and CT, along with gamma pass rates, are presented in ***Table 3***.

A representative case with extensive bowel-related artifacts on CBCT still demonstrated a high gamma pass rate of 95.1% (***Figure 2***)

Conclusions

HyperSight CBCT–based offline adaptive radiotherapy effectively mitigates dosimetric deviations caused by anatomical changes without compromising target coverage. This approach provides a practical and clinically effective alternative to CT re-simulation for GYN radiotherapy delivered on C-arm Linacs.