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Evaluation of three methods to calculate the dose on CBCT in case of IMRT for cervical cancer

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Material and Methods

A total of seven patients treated by IMRT for cervix carcinoma (45 Gy in 25 fractions) had 1 or 2 per-treatment couple(s) of CT and CBCT (corresponding to a total of 10 couples of images). The volumes of interests were delineated on CT. Reference dose distributions were calculated on the CTs, with Pinnacle TPS. CBCT images were first enlarged with assignment of water equivalent density to have the match with the corresponding CT body contour. Three methods of dose calculation on CBCT were compared: i) use of HU to density (HU-D) curve from phantom CBCT image, ii) density assignment method of three structures (air, soft tissues and bones) and iii) deformable image registration (DIR) method deforming the CT on CBCT, creating a deformed-CT (Admire research software, Elekta). As anatomy on CBCT can differ from CT, air pockets from reference CT were applied on CBCT of each method and contours (tumor volume, bladder and rectum) were rigidly registered from CT to CBCT. The dose distributions calculated on the CBCT by each method were compared to the reference CT dose calculation with DVH differences and 3D gamma analysis (local, 3%/3mm, 2%/2mm and 1%/1mm with a 10% dose threshold). The Wilcoxon test was used to compare the dosimetric endpoints.

Results

The figure shows the DVH differences for the tumor volume between dose calculation from CT and from CBCT using each of the methods. DVH differences were significantly lower when using the density assignment method or the DIR method, than when using the HU-D method.

The table shows the mean 3D gamma passrates (percentage of voxels with gamma <1) of each CBCT dose calculation method compared to the reference dose distribution on CT. Gamma passrates were significantly lower for the HU-D curve method than for the density assignment method or the DIR method.

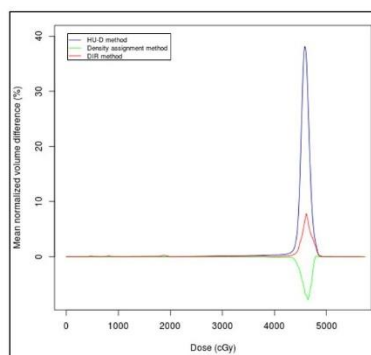


Figure. DVH differences of each CBCT dose calculation method compared to the reference CT for the tumor volume

Gamma criteria	HU-D method	Density assignment method	DIR method
1%/1mm	97 ± 2	100 ± 0.1	99.9 ± 0.1
2%/2mm	89 ± 5	99.3 ± 0.6	99.7 ± 0.3
3%/3mm	66 ± 11	94 ± 4	97 ± 2

Table. Mean 3D gamma passrates ± SD (in percentage) for each CBCT dose calculation method

EP-2003 Evaluation of three methods to calculate the dose on CBCT in case of IMRT for cervical cancer

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Purpose or Objective

To evaluate and compare the dose uncertainties of three methods to calculate the dose on CBCT in case of cervix carcinoma IMRT.

Conclusion

The density assignment and DIR methods are the most accurate methods for CBCT-based dose calculation. Recently, more sophisticated methods based on deep learning lead to interesting results in MRI-based dose calculation. These methods could be evaluated with CBCT images to generate pseudo-CT. The next step is the dose accumulation to quantify the delivered dose during treatment (considering replanning or plan treatment library, if any) for comparison with the planned dose.