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Increased reproducibility of semiautomatic 3D-segmentation over 2D-measurements for quantification of specific iodine uptake of hepatic colorectal metastases in dual-energy CT

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Aims and objectives

With its capability to quantify absolute iodine concentrations, Dual-Energy CT (DECT) promises to add considerable diagnostic information in the field of abdominal oncologic imaging (Agrawal et al., 2014). Iodine maps contain quantifiable information about tumor vascularity and viability and may be used to evaluate treatment response (Apfaltrer et al., 2012; Chen et al., 2014). Hence, reproducible measurements are essential for further treatment decisions. Similar to the measurement of tumor size, the analysis of iodine uptake has hitherto relied on measurements in 2 dimensions (2D) (Zhang et al., 2010). However, recent technological advances enable three-dimensional (3D)-measurements. The aim of this study was to compare interobserver reproducibility of a semiautomatic tool for 3D-segmentation and quantification of iodine uptake in hepatic colorectal metastases with 2D-measurements in DECT.

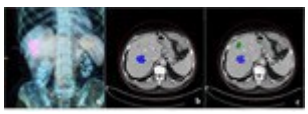

Fig. 1: 3D-segmentation of liver metastases in DECT: exemplary 3D visualization of a segmented metastasis (a). Axial images of mixed series (b, c) demonstrate semiautomatic segmentation of two metastases (blue and green), respectively.

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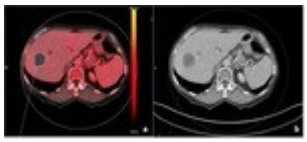

Fig. 2: Manual 2D-segmentation of a liver metastasis in DECT, demonstrated by axially reformated overlay of iodine map and mixed image (a) and the mixed image series (b).

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Methods and materials

For this retrospective study, we included 75 patients with a total of 222 liver metastases. All CT datasets had been acquired on a second-generation dual-source CT (SOMATOM Definition Flash, Siemens Healthcare, Erlangen, Germany) between September 2011 and September 2013. All patients had undergone CT of the abdomen in Dual-Energy mode (140kVp plus tin-filter at a mAsref of 155mAs and 100kVp at a mAsref of 200mAs) as part of routine oncologic staging. A weight-adjusted volume of iodinated contrast agent was administered in all patients (1.5 ml/kg body weight Imeron® 350 mgI/ml, Bracco Imaging Deutschland GmbH).

Two independent observers (one radiologist with 6 years of experience in CT and a second-year resident, respectively) used a novel software prototype ("DualEnergy Tumor Evaluation" running on the prototype platform "eXamine 0.9.3.0", Siemens Healthcare) for semiautomatic 3D-segmentation and Volume-Of-Interest (VOI)-based quantification of specific iodine uptake (mgI/cm³) of all hepatic metastases. After indicating the transverse diameter of a lesion on a representative axial slice, VOIs were automatically calculated and used to quantify specific iodine uptake across the entire lesion (Fig. 1). At an interval of four weeks, manual 2D-Region-Of-Interest (ROI)-measurements were performed by both observers to quantify specific iodine uptake on representative cross-sections for each metastasis (Fig. 2). For these measurements, a commercially available thin-client-server postprocessing solution was used ("Dual-Energy" Workflow in "SyngoVia" Version 2.0, Siemens Healthcare). Both readers were blinded to all clinical data as well as to prior measurements. Correlations were addressed by linear regression with random effects to account for the clustering of metastases within patients. Furthermore, interobserver agreement was quantified using the intraclass-correlation coefficient (ICC). Mean values for both observers and the t-test for paired samples were used to compare absolute values between both methods. Statistical significance was considered for $p < 0.05$.

Results

For all patients and metastases both the 2D- and 3D-measurements were technically successful for both observers and correlation between both methods was high ($r = 0.85$, $p < 0.01$). 3D-VOI-based quantification of iodine uptake yielded slightly but systematically higher values than 2D-ROI-based assessment (1.2 ± 0.48 mgI/cm³ vs. 1.05 ± 0.51 mgI/cm³, $p < 0.05$). Importantly, the 3D-VOI-based approach showed significantly higher interobserver agreement ($r = 0.98$ vs. $r = 0.88$ $p < 0.01$) (Fig. 3).

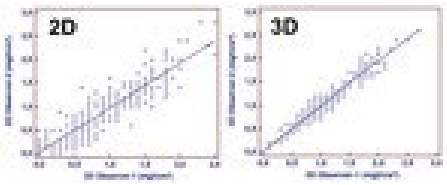

Fig. 3: Interobserver Agreement of Specific Iodine Uptake in mgI/cm³. Comparison between 2D-segmentation (left) and 3D-segmentation (right).

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Conclusion

Reproducible assessment of metastases is important in oncological imaging. Our results suggest that 3D VOI-based evaluation of iodine uptake in hepatic metastases is more precise than 2D-ROI-based measurements since it is associated with significantly higher agreement between two observers. The use of a 3D-VOI-based approach is promising for the future use of this parameter for response evaluation in chemotherapy.

References

1. Agrawal MD, Pinho DF, Kulkarni NM, et al. Oncologic applications of dual-energy CT in the abdomen. Radiographics : a review publication of the Radiological Society of North America, Inc. 2014;34:589-612.

2. Apfaltrer P, Meyer M, Meier C, et al. Contrast-enhanced dual-energy CT of gastrointestinal stromal tumors: is iodine-related attenuation a potential indicator of tumor response? Investigative radiology. 2012;47:65-70.

3. Chen CY, Hsu JS, Jaw TS, et al. Utility of the iodine overlay technique and virtual nonenhanced images for the preoperative T staging of colorectal cancer by dual-energy CT with tin filter technology. PloS one. 2014;9:e113589.

4. Zhang LJ, Peng J, Wu SY, et al. Liver virtual non-enhanced CT with dual-source, dual-energy CT: a preliminary study. European radiology. 2010;20:2257-64.