SSK17-08

Performance Evaluation of Machine-Learning-based Electronic Cleansing Schemes for Ultra-Low-Dose Dual-energy CT Colonography

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PURPOSE

To develop and evaluate accuracy of machine-learning electronic cleansing (ML-EC) schemes for non-cathartic ultra-low-dose dual-energy CT colonography (DE-CTC).

METHOD AND MATERIALS

Thirty-two patients were prepared for non-cathartic colorectal examinations by oral ingestion of 50 ml of iodinated contrast on the day before and two hours prior to DE-CT (SOMATOM Definition Flash) scans. The DE-CTC images were acquired at a current/voltage of 15 mAs/140 kVp and 40 mAs/80 kVp and reconstructed with sinogram-affirmed iterative image reconstruction. Our ML-EC performed a water-iodine material decomposition of the DE-CTC images and calculated virtual-monochromatic (VM) images at multiple energies for preparing radiomic image set, after which a machine-learning method [k-nearest neighbors (kNN), random forest (RF) and deep learning (DL)] was used to label the images into regions of lumen air, soft tissue, fecal tagging, and two types of partial-volume boundaries based on the features of these images. The EC was performed by removing materials other than soft tissues from the original CTC images. For pilot evaluation, 384 volumes of interest (VOIs) where current EC schemes generate typical EC artifacts (Type I: air-tagging boundary; Type II: three-material layer; Type III: three-material mixture) were extracted and labeled into a reference standard. The EC accuracy was evaluated by means of the mean overlap ratio (OR) between the reference standard labels and the labels generated by the ML-EC schemes.

RESULTS

In the DL-based ML-EC scheme, the mean±std of ORs for Types I, II, and III artifacts were 0.984±0.029, 0.932±0.046, and 0.958±0.021, respectively, which were higher than those of kNN-based ML-EC (0.975±0.035 [p<.001], 0.895±0.058 [p<.001], and 0.938±0.027 [p<.001], respectively), and RF-based ML-EC (0.982±0.032 [p=.11], 0.913±0.064 [p<.001], and 0.953±0.025 [p<.001], respectively). Visual assessment confirmed that the DL-based ML-EC generates less EC artifacts than do kNN- and RF-based ML-EC.

CONCLUSION

Our DL-based ML-EC scheme yields superior performance over kNN- and RF-based ML-EC schemes in identifying and minimizing subtraction artifacts on non-cathartic ultra-low-dose DE-CTC images.

CLINICAL RELEVANCE/APPLICATION

Current electronic cleansing methods for visualization of the colonic surface in CTC produce subtraction artifacts. The proposed method shows potential to minimize these artifacts and to facilitate non-cathartic examinations.