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Detection of vulnerable plaque with deep learning algorithm in IVUS imaging

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THEME: Coronary Interventions

TOPIC(S): Stable CAD

AIMS

Near-infrared spectroscopy(NIRS) can detect coronary lipid-core plaque (LCP) leading to fatal future event. We are to reconstruct NIRS images from corresponding intravascular ultrasound (IVUS) images with deep learning method, which have shown high sensitivity and specificity for medical image diagnosis.

METHODS AND RESULTS

We used institutional image database of true vessel characterization (TVC, infraredx Inc, USA) and developed deep learning algorithms for segmenting lumen/adventitia and detecting LCP in coronary vessels. The TVC database of 199 arteries from 116 patients were used as training dataset and 17 arteries from 10 patients were used as validation dataset. First, we segmented lumen and adventitia of vessel as ROI of LCP by training U-net architecture integrated with residual block. After that, a specific type (VGG model) was used for classifying segmented vessel images as low(red) and high(yellow) probability LCP labeled by TVC images. The sensitivity and specificity of the algorithm for detecting high probability LCP were generated on Halogram and Chemogram. Training set consisted of 7,132 rectangles randomly chosen from 151,884 rectangles extracted from IVUS images. Test set was 176 rectangles, randomly chosen from 31,716 rectangles of 10 patients. Vessels' lumen and adventitia can be segmented with 0.95 and 0.9 IoU(Intersection over Union) respectively. For detecting LCP chemogram, IVUS frame images from validation dataset were classified with AUC 0.89 (95% CI, 0.88-0.90), with 85% sensitivity and 91% and specificity. For detecting LCP halogram, rectangular patches extracted from validation IVUS images are classified with AUC 0.88 (95% CI, 0.87-0.89) with 0.80 sensitivity and 0.92 specificity.

CONCLUSIONS

Deep learning method had high IoU for vessels' lumen and adventitia segmentation and high sensitivity and specificity for detecting LCP from IVUS images.