70th International Congress of the European Society for CardioVascular and Endovascular Surgery (ESCVS 2022), 20-23 June 2022, Liege, Belgium

Atherosclerotic Plaque Characterization Using Deep Learning Methods

OBJECTIVE

The automatic extraction of US features such as carotid plaque is essential to pre-estimate the risk of atherosclerosis progression and stratify patients as a high/low risk in terms of plaque stability or vulnerability [1]. Image analysis has the potential to extract valuable information about the plaques and thus to identify more accurately the patients at risk of plaque rupture. The main aim of this study is to characterize atherosclerotic plaque components within carotid artery applying deep learning methods which do not require intensity thresholds and imaging features [2], leading to an optimal use of information and improved prediction power.

METHODS

Clinical US images, obtained in the clinical study of the TAXINOMIS project, have been used as an input. The US images were annotated by expert clinician possessing large experience working with carotid US data. The U-Net, SegNet, and Pyramid Scene Parsing Network (PSPNet) architectures for multi-class image segmentation task have been applied. The original and annotated US images were used for model training and testing. For the training phase we performed 100 epochs, with batch size 2. The problem of atherosclerotic plaque components segmentation was defined as multiclass segmentation model, where four classes should be detected in images: background (black area outside the atherosclerotic ring, pixel map “0”), fibrous (yellow color, pixel map “1”), lipid (blue color, pixel map “2”) and calcified (green color, pixel map “3”) areas of annotated plaque components.

RESULTS

Comparing U-Net, SegNet, and PSPNet architectures for multi-class image segmentation, PSPNet showed a good accuracy in prediction of lipid, fibrous and calcified carotid plaque types based on US images, a bit better than other two architectures. Metric which was recorded during the training phase is mean IoU (Intersection over Union).

CONCLUSIONS

Our preliminary results showed promising accuracy for atherosclerotic plaque type classification, but risk stratification of carotid atherosclerotic patients remains challenging due to complexity of the tissue and additional risk factors which contribute to the stratification. Therefore, this study will be extended to larger patients’ database in order to create more robust model to larger variability applying data mining techniques and US data.

Acknowledgement: This paper is supported by the TAXINOMISIS project that has received funding from the European Union’s Horizon 2020 research and innovation programme under grant agreement No 755320. This article reflects only the author's view. The Commission is not responsible for any use that may be made of the information it contains.

[1] D. Vancraeynest, A. Pasquet, V. Roelants, B.L. Gerber, J.L. Vanoverschelde. Imaging the vulnerable plaque. J Am Coll Cardiol, 57(20): 1961-1979, 2011.

[2] Q. Huang, F. Zhang, X. Li. Machine Learning in Ultrasound Computer-Aided Diagnostic Systems: A Survey. Biomed Res Int, 2018: 5137904, 2018.