Classification of pronounced subclinical atherosclerosis: deep learning approach of carotid intima media ultrasound images is superior to clinical risk factors

Authors:
E Nyman¹, M Karlsson², U Naslund¹, C Gronlund², ¹Umeå University, Public Health and Clinical Medicine - Umeå - Sweden, ²Umeå University, Radiation Sciences, Biomedical Engineering - Umeå - Sweden,

Topic(s):
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Background: Carotid ultrasound measurements of subclinical atherosclerosis is extensively used in the research field of cardiovascular disease. Increased intima media thickness (IMT) and plaque detection have predictive value for cardiovascular events when added to traditional risk factors. However, among studies different protocols for measuring IMT (projections, mean or max values and sites) are used and methodological difficulties of plaque detection, together result in conflicting results. Recently, Deep Learning image driven classification methods, has been successfully applied in several medical imaging applications. Here we hypothesize that ultrasound image texture of the intima media complex accurately reflects the disease burden without the need to measure IMT values or detect plaques.

Purpose: To evaluate classification accuracy of ultrasound based deep learning approach of the intima media complex image compared to traditional risk factors for participants with no vs pronounced subclinical atherosclerosis.

Methods: Subjects from the VIPVIZA study (Visualization of asymptomatic atherosclerotic disease for optimum cardiovascular prevention, n: 3532, 40, 50 and 60 year old, 53% women) were selected for analysis. Bilateral carotid ultrasound examinations were performed according to a standardized protocol. Subjects were categorized in two groups as 1) pronounced subclinical atherosclerosis (n: 401) – bilateral plaques and estimated vascular age 10 years older, or 2) No subclinical atherosclerosis (n: 592) – no plaques and estimated ordinary vascular age. Traditional risk factors for the participants were estimated by the SCORE risk chart. A 1-cm wide region of the distal common carotid artery intima media complex was automatically segmented from the original B-mode images. The images were fed to a Deep Learning model, convolution neural network (CNN), trained using transfer learning model with 60% training data set and 40% evaluation data set. Classification performance was quantified using accuracy of ROC analysis.

Results: The mean age was 58 and 56 years in groups 1 and 2, respectively (with 43% and 56 % women, respectively). The mean SCORE was 1.74 in group 1 and 1.09 in group 2. Classification based on SCORE had an area under the curve of 0.69 with an accuracy of 38%. The Deep learning approach had an area under the curve of 0.89 with an accuracy of 78%.

Conclusion: The results shows that ultrasound image texture of the intima media with Deep Learning approach can be used to detect pronounced disease without explicit measurement of IMT values or detection of plaques. With hard end-points, the approach could be used for risk stratification of subclinical atherosclerosis.
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1 Umeå University, Public Health and Clinical Medicine – Umeå – Sweden, 2 Umeå University, Radiation Sciences, Biomedical Engineering – Umeå – Sweden.

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