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Vascular ultrasound for the assessment of carotid atherosclerosis.

Abstract

Background: Atherosclerotic cardiovascular disease (CVD) is a common cause for mortality globally, and is expected to remain the single leading cause of death as the global population ages and as life expectancy increases.

Cardiovascular screening models have been developed, and continue to be developed, to identify individuals at high-risk of CVD. This is necessary to establish prevention strategies to decrease the occurrence of an acute event or debilitating syndrome. These strategies largely take the form of lifestyle modification and pharmacological intervention. The Framingham risk score, NCEP/ATP II guidelines and SCORE risk assessment protocol are widely used screening models. Ultrasound based methods are non-invasive, affordable and have been suggested to improve assessment and definition of individual patients potential risk of CVD. Increased carotid artery intima-media thickness (cIMT) is a known and established sign of early atherosclerosis. The presence of plaque and the overall burden of atherosclerosis seems to have even greater value in predicting cerebrovascular and cardiovascular events. Ultrasound based texture characteristics of plaques such as entropy, grey scale median, discrete white area, coarseness and juxtaluminal hypoechoic black area have been proposed as useful possible predictors of plaque vulnerability. Moreover, ultrasound contrast agents have been developed to improve visualization and subsequent quantification of an atherosclerotic plaque. Considering the current available data and research, the importance of developing tools and techniques for detection and characterization of atherosclerotic changes, to indicate risk for CVD and the subsequent early intervention and prevention, appears clearly as an effort to improve public health. In this present collection of studies (4 papers) we aim to contribute to the development of clinically useful ultrasound methods and tools for the accurate assessment, understanding and management of atherosclerosis.

Methods: To validate ultrasound-based methods for assessment of early signs of atherosclerosis, measured as cIMT, a total of 144 subjects underwent bilateral carotid ultrasound. In study I, the performance of an ultrasonography software capable of fully automated on-screen cIMT measurements was tested and compared with the traditional manual measurement approach. The coefficient of variation and the intraclass correlation coefficient for both methods were compared to verify the reliability and reproducibility of results generated by the new ultrasound software. To test the accessibility and possible clinical applications of this new technology tested in study I, the new software was used by novice's scanners in study II, and the intraobserver variability of the cIMT measurements were assessed and compared with that of an expert operator. In study III, ultrasound texture characteristics of 327 plaques including entropy, grey scale median, discrete white area, coarseness and juxtaluminal hypoechoic black area were assessed as possible predictors of future cerebrovascular events in a cohort of 133 patients with symptomatic carotid stenosis waiting for carotid surgery. The reproducibility of measuring plaque area (expressed as intraclass correlation coefficient) using conventional ultrasound and contrast enhanced ultrasound was tested in study IV in an attempt to find a simple and reproducible parameter for monitoring changes in atherosclerotic burden.

Results: The technology tested in study I was found to have good inter- and intra-system reproducibility compared with conventional methods. Moreover, it was found to produce reproducible results when used by expert and novice operators after a short period of training (study II), confirming the possibility for the employment of this technology in a large screening public health programs. Although such technology may have immediate practical application, other and more sophisticated ultrasound based plaque characteristics (such as grey scale median, entropy, coarseness, juxtaluminal hypoechoic black area) were not shown to be beneficial in predicting plaque vulnerability (study III). Contrast enhanced ultrasound technic tested in study IV did not improve quantification of atherosclerotic plaque burden.

Conclusion: Medical ultrasound technology by using an automatically measure of carotid intima media thickness can be used with high reproducibility and also possible to be transferred to primary care by a well designed training program. Plaque characteristic using carotid ultrasound was not found to be useful in risk stratifying symptomatic patients with severe carotid stenosis. Furthermore, contrast enhanced ultrasound technique was found to have high reproducibility in plaque area assessment but not better than conventional b-mode based method in quantifying the atherosclerotic burden. Therefore, more sophisticated ultrasound based methods for assessment plaque characteristics was not found to be beneficial in predicting plaque vulnerability.

Keywords

Ultrasound. Plaque. IMT. Atherosclerosis. CEUS. Carotid vessels.

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