

Carotid artery disease: plaque features and vulnerability

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Akademisk avhandling

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Abstract

Background: Atherosclerosis is an important cause of stroke. Ultrasound offers the convenience of real-time and detailed assessment of carotid plaque features as well as arterial wall thickening and composition. Evaluation of these features is important for determining patients' risk of suffering vascular events and also contributes to selecting the best treatment strategy.

Methods: Using ultrasound data analysis we have determined plaque features in the bifurcation and internal carotid artery (ICA), including: surface plaque irregularities, calcification, echogenicity (grey scale median-GSM) and other textural plaque features (Juxtaluminal black area, entropy, coarseness). In addition, intima media thickens (IMT) and its grey scale median (IM-GSM) was measured in common carotid artery (CCA). Using Cone Beam CT (CBCT) we have quantified calcification volume of the carotid plaques extracted after carotid endarterectomy procedure. For the meta-analysis we have used comprehensive meta-analysis software version 3.

Study I: We have included 39 patients and we compared carotid plaque features of the contralateral arteries with those located ipsilateral to symptomatic side and arteries of asymptomatic patients.

Study II: The accuracy of US to detect atherosclerosis calcification was assessed against CBCT in 88 patients.

Study III: Based on the previous vascular events in coronary, carotid and lower extremity arterial system, 87 patients were divided into three groups: asymptomatic, symptoms in one vascular system and symptoms in more that one vascular system. IMT, IM-GSM and plaque features were compared between groups.

Study IV: We have meta-analyzed ten cohort prospective studies evaluating carotid plaque echogenicity for cerebrovascular symptoms prediction.

Results:

Study I. Plaques of the contralateral to symptomatic arteries had similar features to those in symptomatic and more vulnerable than asymptomatic arteries.

Study II. Carotid ultrasound was accurate in detecting calcification volumes of $\geq 8\text{mm}^3$ with very high sensitivity but it was less accurate in detecting lower calcification volumes ($< 8\text{mm}^3$). Carotid calcification was not different between symptomatic and asymptomatic patients.

Study III. Echogenicity of the intima-media complex (IM-GSM), but not its thickness (IMT), was significantly decreased with increasing number of arterial systems affected by atherosclerosis. IM-GSM was lower in patients with prior myocardial infarction and stroke.

Study IV. Carotid plaque echogenicity evaluated by US could predict future cerebrovascular events in patients with asymptomatic, relative risk RR 2.72 (95% CI, 1.86 to 3.96), and recurrent symptoms in symptomatic patients, RR 2.97 (95% CI, 1.85-4.78).

Conclusion: Plaques located in the contralateral to symptomatic arteries have similar features as symptomatic side and more vulnerable than asymptomatic arteries. Carotid ultrasound could accurately detect larger but not smaller carotid plaque calcification volumes ($< 8\text{mm}^3$). Low IM-GSM could identify patients with multi-system atherosclerosis disease, suggesting a better marker for determining systemic atherosclerosis disease burden compared to conventional IMT. Finally, carotid plaque echogenicity predicts future cerebrovascular events in patients with symptomatic and asymptomatic carotid stenosis.

Keywords:

Carotid atherosclerosis, ultrasound, plaque features, echogenicity, calcification, surface plaque irregularities, subclinical atherosclerosis, cerebrovascular symptoms

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