

# Increasing Lipid Core Size in Carotid Plaque is Predictive of Cardiovascular Events in Elder Asymptomatic Individuals Using Contrast-enhanced High-Resolution MRI

J. Cai<sup>1</sup>, Q. Wang<sup>1</sup>, L. Ma<sup>1</sup>, Y. Cai<sup>1</sup>, and Q. Zhao<sup>1</sup>

<sup>1</sup>Radiology, Chinese PLA General Hospital, Beijing, Beijing, China, People's Republic of

## INTRODUCTION:

Complications of atherosclerosis, such as cerebrovascular and cardiovascular disease, are the leading cause of morbidity and mortality worldwide. Being the carotid plaque a possible predictor for future ischemic stroke and cardiovascular events, the connection between its composition and ischemic stroke has been already clarified [1], while the clarification of the same with cardiovascular events is not yet realized [2]. In the present study, by using contrast-enhanced high-resolution MRI we investigated prospectively whether increasing lipid core predicts future new cardiovascular events in elder asymptomatic individuals.

## MATERIALS AND METHODS:

Between January 2003 and June 2008, high-resolution MRI examinations were given to 393 men and women who were 60 to 84 years old and free of clinically apparent cardiovascular disease in our hospital. All enrolled subjects met the following inclusion criteria at the baseline: maximum carotid plaque thickness (MCPT) exceeding 3mm, without disruption of the fibrous cap and intraplaque hemorrhage, and no any previous operation on carotid artery. According to these criteria, total 225 subjects were enrolled in our study. As baseline data, each participant accepted a pre and post contrast-enhanced carotid MRI scan, and then consecutive pre and post MRI examinations every 6-9 months. MRI examinations were performed on 1.5-T or 3.0-T MRI scanner (GE Medical Systems). A bilateral 4-channel phased-array surface coil was used. A standardized protocol was used to obtain 4 different precontrast MR images: (1) double-inversion-recovery T1W (DIR T1W); (2) proton density-weighted (PDW); (3) T2-weighted (T2W); and (4) 3D time-of-flight (3D-TOF) MR angiography. Gadolinium-based contrast-enhanced MR images included double-inversion-recovery T1W. All images were obtained with the following parameters: field-of-view of 14 cm, matrix size of 256-256(512-512 at the MCPT level), slice thickness of 2 mm, and longitudinal coverage of 20 to 24 mm (10 to 12 slices). Investigator manually drew regions of lipid core (LC) area at the MCPT level on the MR images. These regions of interest (ROIs) were computed automatically by using a custom image analysis tool. Of the 225 original patients, 14 were excluded due to bad image quality during follow-up. The *t* test was applied to estimate whether there was statistical significance in the change of LC size. The Cox proportional-hazards regression model was used to assess the association of increasing lipid core and the occurrence of new cardiovascular diseases. Calculations were performed with statistical software (version 15.0, SPSS).

## RESULTS & DISCUSSION:

The median follow-up was 3.0 years (maximum, 4.4). There were 61(29%) of 211 patients who suffered from new vascular events including 23 anginas, 16 myocardial infarctions (MIs), and 22 cardiovascular deaths. In the group (n=61) with new vascular events, the LC areas were  $7.17 \pm 3.21 \text{ mm}^2$  (mean  $\pm$  SD) at the base-line (Figure 1),  $14.29 \pm 4.01 \text{ mm}^2$  at the endpoint (Figure 2), and the *t* value is 4.82 (*P*=0.0001). In the group (n=150) without new vascular events, the LC areas were  $6.53 \pm 3.36 \text{ mm}^2$  (mean  $\pm$  SD) at the base-line, the LC areas were  $6.72 \pm 3.61 \text{ mm}^2$  at the endpoint, and the *t* value is 0.75 (*P*=0.46). In a Cox proportional-hazards regression, the increasing size of lipid core was significantly associated with the risk of the new vascular events (RR=1.63; *P*=0.027; 95% CI, 1.053~2.364). After adjusting for other risk factors, including blood cholesterol levels, hypertension, diabetes mellitus, smoking, this association remained significant (RR=1.56; *P*=0.031; 95% CI, 1.04~2.27). Recently, Ultrasound(US) studies of the increasing echolucency of carotid plaques have generally shown associations with cardiovascular events in high-risk patients[3]. However, US is unable to discriminate lipid from intraplaque hemorrhage, which is an independent risk factor subsequently predicting clinical outcomes[3]. Our results suggest that increasing lipid core can help to identify patients at risk for future cardiovascular events.

## CONCLUSION:

Elder asymptomatic adults with increases of lipid core in carotid plaque are at a high risk of future cardiovascular disease. Being a noninvasive and accurate measure tool for lipid core, repeated contrast-enhanced high-resolution MRI may be helpful to predict future cardiovascular events and improve the effectiveness of therapeutic strategies.

## REFERENCES

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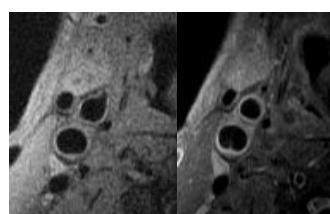


Figure 1 (a) (b)  
A 63-year old male patient had right carotid plaque.  
(a)T1WI, (b)Gadolinium-based contrast-enhanced T1WI.

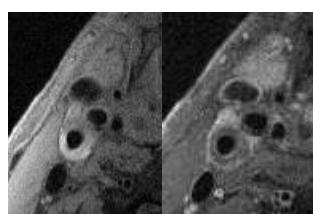


Figure 2 (a) (b)  
The same patient suffered from myocardial infarction 2 year later with increasing lipid core in right carotid plaque.