Assessment of fibrous cap status of carotid artery plaques by contrast-enhanced MRI

R. Kwee1,2, W. Mess2, R. van Oostenbrugge1, C. Franke3, F. Schreuder4, A. Korten2, B. Meems5, J. Wildberger2, J. van Engelshoven2,6, and E. Koor4

1Department of Radiology, Maastricht University Medical Center, Maastricht, Limburg, Netherlands, 2Department of Clinical Neurophysiology, Maastricht University Medical Center, Maastricht, Netherlands, 3Cardiovascular Research Institute Maastricht, Maastricht, Netherlands, 4Department of Neurology, Maastricht University Medical Center, Maastricht, Netherlands, 5Department of Neurology, Atrium Medical Center Heerlen, Heerlen, Netherlands, 6Department of Radiology, Maastricht University Medical Center, Maastricht, Netherlands

Background and purpose
The fibrous cap (FC) is a layer of connective tissue separating the lipid-rich necrotic core (LRNC) of the plaque from the carotid artery lumen. Patients with a thin or ruptured FC may be at greater risk for future stroke. Overall reproducibility in identifying the FC by non contrast-enhanced (CE-) MRI has shown to be poor.1 CE-MRI is capable of quantitatively measuring the dimensions of the intact FC.2 The objective of this study was to assess inter- and intraobserver agreement of CE-MRI in the assessment of FC status in vivo.

Methods
The plaques of forty-five symptomatic patients with moderate (30-69%) carotid artery stenosis were imaged in-vivo by co-registered 3D T1-weighted (T1w) turbo field echo (TFE), 3D time-of-flight (TOF), and pre- and post-contrast 2D T1w turbo spin-echo (TSE) images, using a 1.5-Tesla whole-body MRI system (Intera, Philips Medical Systems, Best, the Netherlands). For each slice (3 mm thickness, 9 slices per plaque), presence or absence of LRNC/hemorrhage1,2 and FC status2 were independently assessed by three observers, of which one also assessed all images 2 months after the first reading. Assessment criteria are listed in Figure 1. For assessment on a per-plaque basis, FC status was considered “thin or ruptured” when at least one slice was scored as being “thin or ruptured”. Kappa coefficients (κ) were calculated as indicators of inter- and intraobserver agreement, on a per-slice and on a per-plaque basis. Kappa values <0.20, 0.21–0.40, 0.41–0.60, 0.61–0.80, and 0.81–1.00 were considered to indicate poor, fair, moderate, good, and very good agreement, respectively.

Results
Interobserver agreement in FC status assessment on a per-slice basis was moderate to good (κ values of 0.58, 0.63, and 0.66; all P<0.05). Intraobserver agreement on a per-plaque basis was good (κ=0.79, P<0.05). Interobserver agreement in FC status assessment on a per-plaque basis was good (κ values of 0.64, 0.69, and 0.78; all P<0.05). Intraobserver agreement on a per-plaque basis was very good (κ=0.99, P<0.05).

Conclusion
This study found good inter- and intraobserver agreement in assessing FC status on a per-plaque basis by using CE-MRI. Future prospective longitudinal studies can rely on CE-MRI to assess the predictive value of FC status of carotid artery plaques on the occurrence of cerebral ischemic events.

Figure 1. Criteria used to assess FC status.

Figure 2. Four co-registered MRI sequences (T1w TFE, TOF, pre- and post-contrast T1w TSE) of a transverse section of a plaque in the left internal carotid artery. In this case, all three reviewers observed a plaque with an area of LRNC/hemorrhage and a ruptured FC (arrow in post-contrast T1w TSE image).

Figure 3. Four co-registered MRI sequences (T1w TFE, TOF, pre- and post-contrast T1w TSE) of a transverse section of a plaque in the left internal carotid artery. In this case, all three reviewers observed a plaque with an area of LRNC/hemorrhage and an intact FC (arrow in post-contrast T1w TSE image).

References