

Evaluation of the Fibrous Cap Rupture of the Atherosclerotic Carotid Plaque by In Vivo Contrast-Enhanced High Resolution MRI

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Introduction

The intact of the fibrous cap (FC) of the atherosclerotic carotid plaque is a factor of plaque stability. Recent study demonstrated that high resolution MRI is capable of distinguishing the ruptured fibrous cap of the atherosclerotic carotid plaque from the intact fibrous cap by the 3D TOF sequence [1]. Report [2] has also shown that contrast enhanced (CE) MRI could provide more information about the tissue characterization of the carotid plaque. In this study, we assess the value of the *in vivo* high-resolution CE MRI in the evaluation of the FC rupture of the carotid plaque by compared with 3D TOF sequence.

Materials and Methods

High-resolution MRI of carotid arteries from 24 patients with stenosis $\geq 50\%$ were performed on a 1.5T GE Signa scanner with a custom-designed phased-array coil. MR sequences included double inversion recovery (DIR), fast spin echo (FSE) T1WI [TR/TI/TE: 800/650/9] and 3D time of flight (TOF) [TR/TE: 23/3.6]. The T1W scan was repeated ~ 10 minutes after the injection of a contrast agent (0.1mmol/kg, Magnevist, Schering). Section thickness was 2mm in T1W and 1 mm in TOF. In-plane pixel size was 0.25x0.25 mm². The matched 3D TOF, pre- and post-CE T1W MR images were used for the evaluation. In TOF MR images, thick FC appear as a juxtaluminar band of low signal, whereas in plaque with FC rupture, the dark band is absent and there is a region of hyperintense signal adjacent to the lumen [1]. In post-CE T1W MR images, a region of strong enhancement adjacent to the lumen indicates a ruptured FC with or without associated neovasculature. The Kappa (*k*) values were calculated to measure the level of agreement between CE MRI and 3D TOF MRI in determining the rupture of FC.

Results

Among all the 48 carotid arteries, 36 arteries were $\geq 50\%$ stenosis and could be used for the study. There were 248 slices matched between CE MRI and TOF MRI. There is a high level of agreement between CE MRI and TOF MRI in determining the rupture of FC: $k=0.80$ (Table 1, Figure 1 and Figure 2). The sensitivity of CE MRI is 92%, and the specificity is 90%. Among the disagreed slices, 16 of them were positive by CE MRI but negative by TOF MRI, whereas 7 of them were negative by CE MRI but positive by TOF MRI. CE MRI diagnosed more ruptured FC than TOF MRI (92 vs 83).

Conclusions

High-resolution CE MRI is capable of determining the FC rupture of the atherosclerotic carotid plaque. With the additional information provided by the contrast agent for the characterization of plaque tissues, CE MRI might be more sensitive than TOF MRI, which has limit spatial resolution, in determining the FC rupture. This needs be studied in the future with histology.

References

- Hatsukami TS, et al. Circulation 2000; 102: 959-964.
- Yuan C, et al. J Magn Reson Imaging 2002; 15: 62-67.

Table 1: 2 x 2 performance table for identifying an ruptured fibrous cap: comparing the CE T1W MRI findings with TOF MRI.

CE T1W MRI	TOF MRI		
	Ruptured FC	Intact FC	Total
Ruptured FC	76	16	92
Intact FC	7	149	156
Total	83	165	248

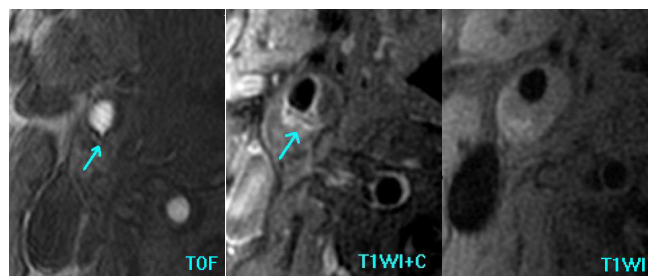


Figure 1: In TOF MR images, at the region of FC rupture, the dark band is absent and there is a region of hyperintense signal adjacent to the lumen. In post-CE T1W MR images, a region of strong enhancement adjacent to the lumen indicates a ruptured FC with or without associated neovasculature.

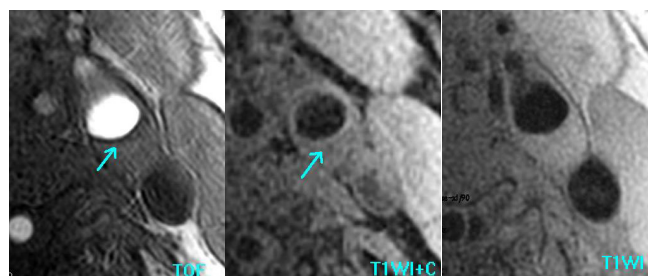


Figure 2: In TOF MR images, thick FC appears as a juxtaluminar band of low signal. In post-CE T1W MR image, there is not focal region of enhancement adjacent to the lumen.