

MRI of Unstable Carotid Plaque: Correlation between Heavy T1-weighted imaging and Pathology

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BACKGROUND

Noninvasive characterization of carotid plaque with use of MRI is one of the current topics. Recently, Moody, Murphy, et al. reported that a heavy T1-weighted imaging (“direct thrombus imaging” in their term) is useful to visualize recent thrombus, and was related to recent cerebroischemic episode [1,2]. In their reports, however, correlation between MRI and pathology was not described precisely, and time-span of thrombus with high signal is not resolved. The purpose of this study was to solve if high signal on T1-weighted imaging is related to recent thrombus or other tissue including lipid rich core.

METHODS

Between Nov. 2002 and May 2003, total 11 consecutive patients scheduled for carotid endarterectomy were recruited for this study. All the patients underwent carotid artery MRI within 2 weeks of the surgical procedure.

MRI was performed with a commercially available neck array coil on a 1.5T scanner (Magnetom, Sonata). MR sequence used for plaque imaging was a heavy T1-weighted three-dimensional imaging: magnetization prepared rapid acquisition with gradient echo (MPRAGE) in which inversion time (TI) was adjusted to null blood condition, and water selective excitation technique was employed to null fat signal. Signal intensity of plaque on MPRAGE was compared with adjacent muscle (typically, sternocleidomastoid muscle), and categorized into three groups: almost wholly high, partially high and iso-intensities.

The specimens were fixed in 10% formalin, decalcified and embedded in paraffin. Samples were sectioned every 2.5 or 5mm from the bifurcation of the carotid artery to the distal and proximal end of the specimens, and stained with hematoxylin-eosin and Masson trichrome.

MR images and histopathological sections were matched using the landmarks such as the common carotid bifurcation.

RESULTS

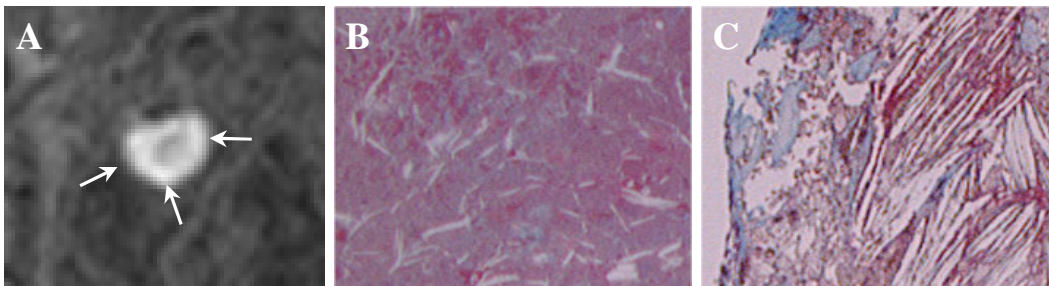
Of the 11 patients who underwent carotid endarterectomy, 2 patients were excluded from this study because of distortion and fragmentation of the specimen.

Two plaques revealed almost wholly high signal intensity. The plaques had liquid components when they were surgically removed, and had much lipid rich core with hemorrhage pathologically. The plaques had a markedly high signal in the peripheral portion where abundant lipid and red cells were observed. The central portion, where old hemorrhage and necrotic tissue with lipid were observed, had relatively low signal to the peripheral portion (FIGURE). Two iso-intensity plaques had no lipid rich core with red cells, and mainly composed of fibrous tissue. In one of the two iso-intensity plaques, lipid rich core without red cells was observed. Five plaques revealed partial high intensity on MPRAGE, and the high intensity corresponded to lipid rich core with hemorrhage.

DISCUSSION AND CONCLUSION

The results showed that high signal on MPRAGE did not correspond to pure hemorrhage, nor corresponded to pure lipid rich core. High signal plaque included old hemorrhagic and necrotic tissue with lipid as well as lipid rich core with red cells. Follow up study of carotid plaque revealed that high signal was almost unchanged over a number of months (unpublished data). Therefore, high signal is not restricted to recent thrombus. Further investigation is necessary.

FIGURE. **A.** MPRAGE shows a plaque with almost wholly high signal intensity (arrows). Signal intensity in the peripheral portion is higher than that in the central portion. **B.** Zoomed image of the central portion (Masson) shows lipid and old hemorrhage. **C.** Zoomed image of the peripheral portion (Masson) shows lipid and red cells.



REFERENCES

1. Moody, et al. *Circulation* **2003**;107: 3047-3052.
2. Murphy, et al. *Circulation* **2003**;107: 3053-3058