Magnetic Resonance Imaging of Carotid Plaque in Restenosis after Carotid Endarterectomy

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Introduction

Early restenosis after carotid endarterectomy (CEA) is observed in 1-37% of the patient who received it (1), and thought to be a result from neointimal hyperplasia. However, little is known about preoperative Magnetic Resonance (MR) characteristics of restenotic plaques. We investigated the association between preoperative MR plaque imaging and restenosis after CEA.

Methods

Between 2003 and 2010, 113 carotid arteries of 108 patients undergoing CEA were included. We used 2D gradient-echo black-blood T1-weighted imaging at 1.5T for the evaluation of plaque characteristics. We estimated relative overall signal intensity of plaque components. Plaques that had signal intensity of T1roSI>=1.25 were defined as vulnerable plaque. The patients underwent MR plaque imaging before surgery. Patency after CEA was assessed with ultrasonography, MR angiography, and digital subtraction angiography. Restenosis was defined as recurrent luminal narrowing>=50% in either modality at the endarterectomy site. Association between the occurrence of restenosis after CEA and preoperative MR plaque imaging was investigated.

Results

Thirteen arteries of 13 patients were lost to follow-up within 1 year (2 arteries were occluded within 7 days after operation, 3 patients were died within 1 year, Figure 1).

Figure 1 Schematic drawings of the cases included in this study.
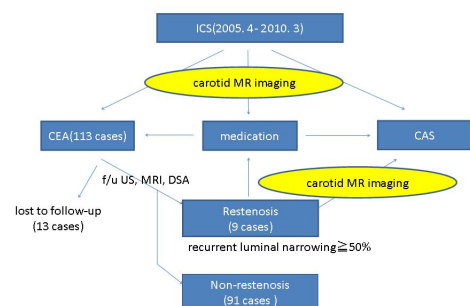
100 arteries of 95 patients were included in the study. Recurrent carotid stenosis was observed in 9 arteries, 8 of which were performed preoperative MR plaque imaging, and their mean T1roSI was 1.17±0.17. There were 91 arteries without restenosis after CEA, 76 of which were performed preoperative MR plaque imaging, and their mean T1roSI was 1.32±0.22. Preoperative T1roSI of restenotic arteries was lower than that of non-restenotic arteries, but the difference was not statistically significant (95% CI, -0.02-0.31; P=.080, Table 1).

	CEA w/ restenosis	CEA w/o restenosis	P (95%CI)
n	9	91	
age	66.0 ± 13.4	71.0 ± 5.9	0.30 (-15.3 ~ 5.4)
sex (male : female)	9 : 0	85 : 6	1.0
symptomatic	6 (66.7%)	61 (67.0%)	1.0
Stenosis rate (%)	82.8 ± 9.1	75.9± 16.9	0.31 (~)?
side (Rt / Lt)	6 / 3	42 / 49	0.31
HT (%)	9 (100%)	74 (81.3%)	0.35
DM (%)	2 (22.2%)	35 (38.5%)	0.48
HL (%)	6 (66.7%)	34 (37.4%)	0.15
IHD (%)	1 (11.1%)	21 (23.1%)	0.68
T1-roSI	1.17 ± 0.17 (n=8)	1.32 ± 0.22 (n=76)	0.08 (-0.31 ~0.02)
T2-roSI	0.78 ± 0.12 (n=7)	0.87 ± 0.32 (n=76)	0.66 (-0.10 ~0.15)

Table 1: Preoperative MR plaque imaging

Plaque MRI after restenosis was taken in 4 arteries. Their mean T1roSI was 0.98±0.10, significantly lower than that of all preoperative plaques (Table 2).

	Preoperative MRI	MRI after restenosis	P (95%CI)
T1-roSI	1.31 ± 0.22 (n=84)	0.98 ± 0.10 (n=4)	0.01 (-0.54~ 0.07)
T2-roSI	0.84 ± 0.29 (n=83)	0.77 ± 0.37 (n=3)	0.77(-0.97~ 0.82)

Table 2 MR plaque imaging after restenosis

Discussion

In this study, preoperative T1-roSI of restenotic plaques seemed lower than that of non-restenotic plaques. Williem E et al reported that histopathologically lipid-rich, inflammatory plaque is associated with low risk of restenosis (2). Lipid rich plaque and/or plaque with intraplaque hemorrhage has hyperintensity in T1-weighted images. These findings support our results. T1-weighted roSI of plaques after restenosis was lower than that of all preoperative plaques. Early restenosis is mainly caused by intimal hyperplasia due to proliferation of smooth muscle cells, rather than intraplaque hemorrhage (3). Therefore, plaques after restenosis showed T1 hypointensity in our study.

Findings on MR imaging of plaque components

Histologic Features	T1-Weighted Images	T2-Weighted Images
Fibrous cap	Hypointensity	Hypointensity
Fibrosis	Isointensity	Isointensity
Calcification	Hypointensity	Hypointensity
Myxomatous tissue	Isointensity	**Hyperintensity**
Lipid core with IPH	**Hyperintensity**	Variable
Lipid core without IPH	**Isointensity**	Variable

* IPH: intraplaque hemorrhage   Am J Neuroradiol 2008; 29: 868-74

Limitation

This is retrospective study and based on a small group of patients.We did not examine plaques histologically.Duration of follow up after CEA varies among patients.

Conclusions

Preoperative T1-weighted images of restenotic plaque seemed lower than that of non-restenotic plaques. Further investigation will confirm the preoperative MR characteristics of restenosis after CEA.

References

1)Br J Surg 1997; 84: 1206-19
2)JAMA. 2008; 299(5): 547-554
3)Stroke. 2008; 39: 1029-1032

Learning Objectives

By the conclusion of this session, participants should be able to identify the characteristics of carotid plaques in restenosis after CEA.