

# Black-Blood Vessel wall imaging of carotid arteries; correlation with pathological findings

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## Introduction

Atherosclerotic carotid disease is a major cause of cerebral ischemia such as cerebral infarction. The risk of thromboembolism is more dependent on the plaque configuration than on the degree of luminal narrowing. Histopathological studies suggest that high-risk plaque is typically soft and consists of a large lipid-rich necrotic core, intraplaque hemorrhage, significant inflammation, and thin fibrous cap.

MRI is superior to other imaging modalities in tissue contrast. Especially, Black-blood (BB) technique using double inversion recovery provides excellent flow-related signal suppression, so the conspicuity of the vessel wall is increased. High resolution BB-MR imaging expects to characterize the components of atherosclerotic plaque.

We performed high-resolution BB-MR imaging in the patients scheduled to undergo carotid endarterectomy and classified the plaques into soft plaque or hard plaque according to intraoperative and pathological findings. The purpose of this study was to assess the signal intensities of soft and hard plaques on BB-MR images and whether BB-MR imaging could distinguish soft plaque from hard plaque.

## Purpose

To assess the signal intensities of soft and hard plaques on BB-T1 WI and BB-T2WI and investigate capability to distinguish soft plaque from hard plaque.

## Materials and Methods

Between May 2002 and August 2003, fifteen patients underwent Black-blood (BB) MR plaque imaging and carotid endarterectomy with histological examination.

MR imaging was performed on a 1.5T unit (Intera, Philips medical systems) using a surface coil (8 cm in diameter). MR angiography was first performed to determine lesion level using a 3D time-of-flight gradient echo sequence. BB-MR imaging was performed at three levels of the major stenosis on each side of internal carotid arteries. To obtain BB-MR images, we use double inversion recovery sequence with cardiac gating. Both T1-WI and T2-WI were obtained in each patient. BB-T1-WI parameters were as follows: TR, 700-1000ms; TE, 13-20ms; slice thickness, 3mm; FOV, 150mm; matrix, 256; scan time 3-4min. BB-T2-WI parameters were as follows: TR, 1500-2000ms; TE, 80ms; slice thickness, 3mm; FOV, 150mm; matrix, 256; scan time 3-4min. Fat suppression (FS) was used to reduce signal from subcutaneous fat.

The plaques were classified into four groups according to the findings at surgery and pathological findings (A; soft plaque most, B; soft plaque more than half, C; hard plaque more than half, D; hard plaque most). Soft plaque mainly consisted of lipid-rich core, hemorrhage, and significant inflammation. Hard plaque consisted of fibrosis or calcification. Signal intensities of plaques on BB-MRI were compared to submandibular gland.

## Result

1. Table 1 summarizes the signal intensities of plaques on BB-MRI and pathological classification in each patients.

2. In 5 cases classified as soft plaque (A or B), plaques appeared iso- or hyperintense compared to submandibular gland on BB-T1WI and BB-T2 WI. Of these, in 3 cases, plaques appeared apparent hyperintensity on both images (Fig.1).

3. In 8 cases classified as hard plaque (D or C), plaques appeared iso- or hypointensity compared to submandibular gland on both BB-T1 WI and BB- T2 WI. Of these, in 5 cases, plaques show hypointensity on BB-T2WI (Fig.2).

## Conclusion

Hyperintense plaque on both BB-T1WI and BB-T2WI was soft plaque. Hard plaques appear iso- or hypointensity on both BB-T1WI and BB-T2WI. BB-MRI is capable of distinguishing soft plaque from hard plaque.

**Table 1** Summary of signal intensities and classification of the plaques.

Signal intensity on BB-MRI: VH, very high; H, hyperintensity; I, isointensity; L, hypointensity compared to submandibular gland.

Histological classification: A: soft plaque most, B: soft plaque more than half, C: hard plaque more than half, D: hard plaque most

**Figure 1** Soft plaque (Pt. 4 classified as B)

A: BB-FS-T1WI B: BB-FS-T2WI

Plaque is seen as very high-signal intensity on BB-T1WI, compared to submandibular gland (\*) on BB-T2WI.

**Figure 2** Hard plaque (Pt. 11 classified as D)

A: BB-FS-T1WI B: BB-FS-T2WI

Compared to submandibular gland (\*), plaque is seen as isointensity on BB-T1WI, hypointensity on BB-T2WI.

		BB-FS-T2 WI			
		VH	H	I	L
BB FS-T1 WI	VH	B (pt.3)	B (pt.4)		
	H		A (pt.2)	A (pt.1) D (pt.14)	
	I	C (pt.6)		B (pt.5) C (pt.7) D (pt.10) D (pt.13)	D (pt.11) D (pt.9) D (pt.12) D (pt.15)
	L				D (pt. 8)

