Inter-reader Reproducibility for Carotid Territory Cerebral Vascular Infarcts: A 3.0T Magnetic Resonance Imaging Study

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Background: Carotid atherosclerosis is one of several etiologies for cerebrovascular incidents arising from extra cranial arteries [1-3]. In order to accurately and reliably evaluate the associated risk of stroke from carotid atherosclerosis, it is necessary to identify and classify brain lesions in the carotid territory. Reliable reading of brain lesion MR images therefore becomes critical. To date, the criteria for reading these images have not been well standardized.

Objective: We sought to determine the inter-reader reproducibility in the assessment of carotid territory brain lesions.

Materials and Methods: Subjects (n = 67) were drawn from a study aiming to investigate the association between carotid atherosclerosis and brain lesions. All subjects had greater than 50% carotid stenosis on at least one side. They all underwent brain MR imaging at 3.0T (Signa Excite, General Electric Healthcare). T1-weighted (TR/TE: 461/13 ms, matrix: 336×512), T2-weighted (TR/TE: 4260/101 ms, matrix: 224×512), diffusion weighted images (DWI, TR/TE: 3100/176 ms, *b*=1000 , matrix: 224×512) sequences were acquired. Two readers independently reviewed the images and classified each hemisphere by the following characteristics (Figure 1): lesion presence, size, and age. Lesion presence was defined as an infarct in either of the anterior cerebral artery or middle cerebral artery territories. Lesion size was defined as **large** = greater than 3 mm^2 in dimension, **small** = less than 3 mm^2. Lesion age was defined as **fresh** for lesions with a hyperintense signal on DWI, and **old** for lesions with hypo- and iso-intense signals on T1 and DWI, respectively. Cohen's Kappa (κ) was used to measure agreement. According to Landis and Koch [4], values of κ between 0.8 and 1 indicate near perfect agreement, 0.6 to 0.8 substantial agreement, 0.4 to 0.6 moderate agreement, 0.2 to 0.4 fair agreement, and 0.0 to 0.2 poor agreement.

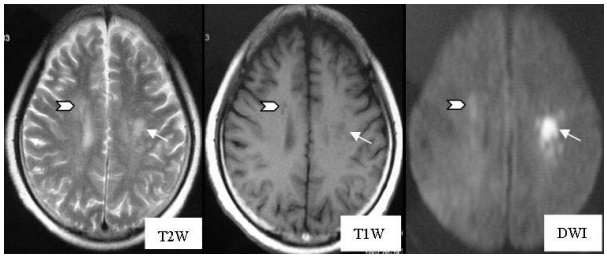

Fig 1: Lesion Classification in carotid territory. Large fresh lesion present in the left hemisphere (arrow) and small old lesion in the right hemisphere (chevron)

Results: All brain scans had sufficiently good image quality for review (n=134 hemispheres). The inter-reader agreement was substantial (κ = 0.67; 0.54-0.80) for the classifications of lesion presence. The classification of size and age was further analyzed for the hemispheres where both readers agreed on the presence of a brain lesion (n = 65). For these cases, the inter-reader agreement was substantial (κ = 0.75; 0.60-0.92) for lesion size, and there was complete agreement (κ = 1.0) for age (Table 1). Of the disagreements on presence, size, or age (n = 30), 63% occurred between absence of lesion and small old lesion, 27% between small old lesion and large old lesion, and only 10% between absence of lesion and large old lesion. There were no disagreements between absence of lesion and fresh lesion. Furthermore, in the 19 cases with fresh lesions, there were no disagreements on size.

Table 1. Reproducibility for carotid territory brain lesion classification

	% Agreement	κ (95% CI)
Lesion presence (n=134)	83.6%	0.67 (0.54-0.80)
Lesion size (n=65)	87.7%	0.75 (0.60-0.92)
Lesion age (n=65)	100%	1.00

Discussion: The inter-reader reproducibility for MR classification of brain lesions in the carotid territory was substantial. Some disagreements on the presence or absence of lesions may be due to their location near the boundary of the carotid territory. It is important to point out old lesions, small old lesions in particular, were the primary factor that reduced reproducibility. There was complete agreement on presence and size for fresh lesions, most likely due to the highly distinct signal on diffusion weighted images.

Conclusions: The MR criteria used in this study for classifying carotid territory brain lesions are reproducible between readers. However, the reproducibility for old lesions and small lesions needs to be improved. This variability should be taken into account in the design of studies investigating the association between carotid atherosclerosis and brain lesions.

Reference: [1] Chaer R, et al. *Rev Recent Clin Trials.* 2006;1(3):293. [2] Chambers BR, Norris JW. *N Engl J Med.* 1986;315:860. [3] Hennerici M, et al. *Brain.* 1987;110(pt 3):777. [4] Landis JR, Koch GG. *Biometrics*. 1977;33:159.