

BACKGROUND & PURPOSE

Given the burden of vascular disease in Canada, CAIN1 is a pan-Canadian multicentre brain and carotid imaging project focused on understanding the natural history of carotid disease and effect on cerebrovascular outcomes. The primary outcome of this study is to accurately characterize carotid plaque morphology in non-surgical patients with mild to moderate (50-70%) carotid disease. We will also assess evidence of ischemic brain disease.

CAIN1's central objective is the translation of imaging innovations into clinical practice aimed at cardiac and neurological diseases [1,2]. Here we describe preliminary brain and carotid imaging association results from a cross-section of n=291 baseline participants with non-surgical carotid disease.

RESULTS

Demographics		
Age	69.95 (7.63)	
Sex, n (%) male	132 (65.3)	
Neuroimaging Volumetrics		
	Left	Right
Periventricular WMH, med (IQR)	2517.04 (4083.92)	2527.96 (3777.68)
Deep WMH, med (IQR)	241.52 (485.99)	241.93 (507.28)
Periventricular Lacune, med (IQR)	12.00 (61.84)	19.22 (83.98)
Deep White Lacune, med (IQR)	0.00 (0.00)	0.00 (0.47)
TIC	619.19 (65.51) ^a	629.27 (66.13) ^a
Carotid Imaging Measures		
	Left	Right
Lumen	0.94 (0.29)	0.94 (0.33)
Outer Wall	2.24 (0.57)	2.23 (0.61)
LRNC	0.06 (0.06)	0.05 (0.05)
Calcified Tissue	0.02 (0.03)	0.02 (0.04)
Vessel Wall	1.30 (0.38)	1.28 (0.38)
IPH	0.04 (0.10)	0.04 (0.10)
Fibrous Cap	0.95 (0.71)	0.99 (0.70)
Ulcer	0.00 (0.01)	0.00 (0.01)
Lumen Min	3.18 (1.26)	3.19 (1.18)
Lumen Max	4.76 (0.91)	4.75 (0.69)
Stenosis, %	23.1 (25.8)	24.2 (25.5)

Table 1. All data presented in Mean (SD) unless otherwise stated. Volumetrics presented in mm³ unless otherwise stated. ^aData in cc. WMH=White Matter Hyperintensity, TIC=Total Intracranial Capacity, LRNC=Lipid-Rich Necrotic Core, IPH=Intraplaque Hemorrhage.

Multiple linear regression using backwards elimination of non-significant variables was used to examine associations between neuroimaging and carotid measures for each hemisphere. Brain volumetrics were head-size corrected and normalized.

For the left hemisphere, regression results revealed the following associations: pWMH with lumen volume (p=0.002), and lacunes with vessel wall volume (p=0.037). For the right hemisphere, regression results revealed the following associations: pWMH with lumen (p<0.0001), and lacunes with vessel wall volume (p=0.009). No significant associations were observed with dWMH. As expected, age was a significant predictor of all neuroimaging measures.

METHODS

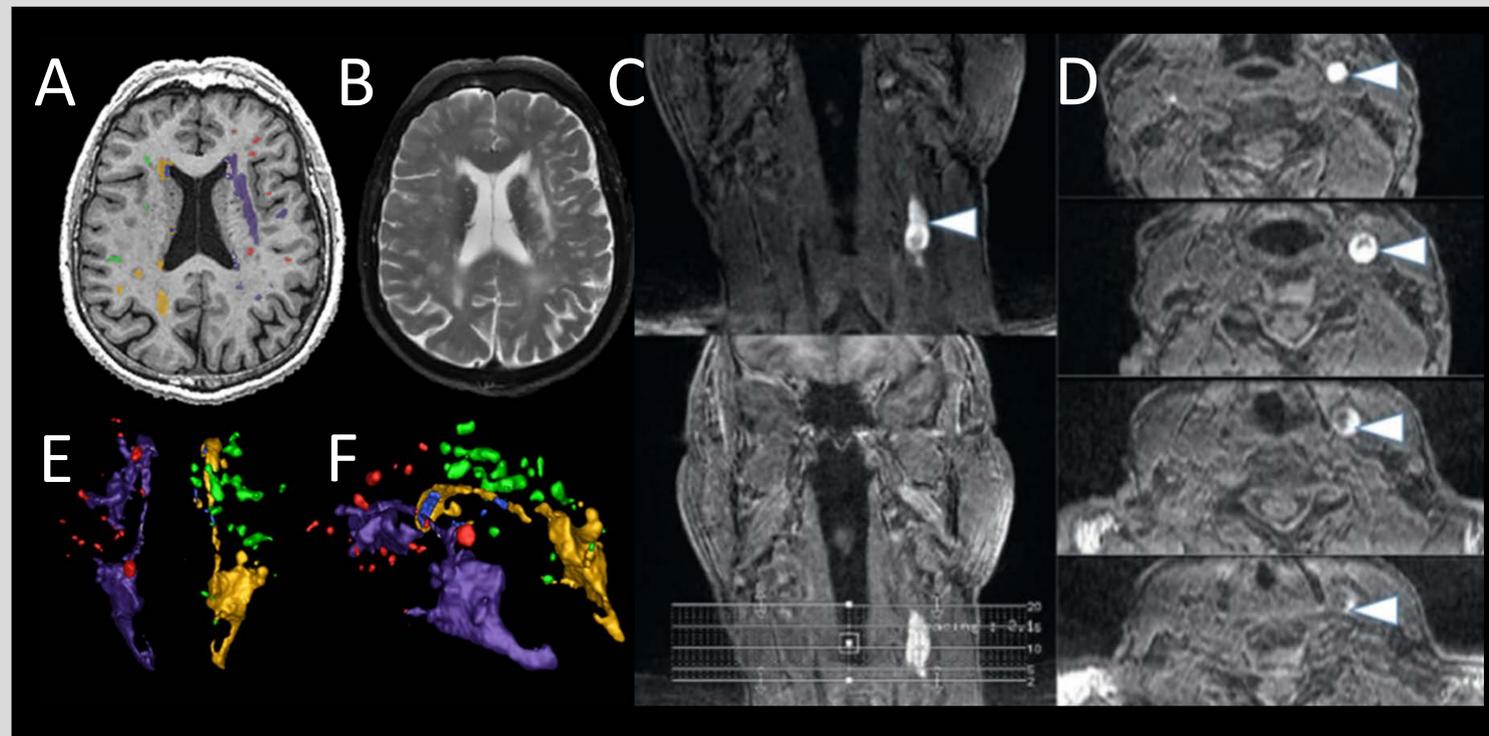


Figure 1. A) Colors show periventricular (pWMH) and deep (dWMH) white matter hyperintensities overlaid in axial view of T1-weighted brain MRI. B) T2-weighted brain MRI for visualization of WMH. C&D) Arrows point to intraplaque hemorrhage (IPH) indicated by signal hyperintensity in the vessel wall shown in coronal (C) and axial (D) views of T1-weighted carotid MRI [3]. E&F) 3D volume render of left (purple) and right (yellow) pWMH, and dWMH (green and red) visualized from the top (E) and slightly rotated (F) views.

BRAIN

Structural brain MRI (3.0 Tesla: T1, PD/T2, T2 FLAIR) was analyzed using SABRE-Lesion Explorer [4] to obtain left and right hemisphere measures of cerebral small vessel disease (SVD): periventricular and deep white matter hyperintensities (pWMH, dWMH), and lacunar infarcts.

CAROTIDS

MRI-based (3D-T1 fat suppressed fast field echo) measures of left and right carotid atherosclerosis include: lumen vol International Journal of Cardiovascular Imaging ume, lipid-rich necrotic core volume (LRNC), calcified tissue, vessel wall volume, intraplaque hemorrhage volume (IPH), fibrous cap volume, ulcer, lumen min/max, and stenosis (%).

CONCLUSION

In summary, results suggest that bilateral periventricular SVD (indicative of venous collagenosis) is associated with carotid measures of the lumen, while lacunar infarcts are associated with vessel wall volume. These preliminary results based on a cross-section of CAIN1 study participants suggest a potential relationship between carotid atherosclerosis and end-organ SVD.

FUTURE DIRECTIONS

Pending clinical data cleaning and imaging analysis, the following future directions are currently underway:

- 1) Evaluation of plaque components, specifically intraplaque hemorrhage.
- 2) Serial assessment of longitudinal data.
- 3) Consideration of clinical outcomes and vascular risk factors/medical history (hypertension, diabetes mellitus, hyperlipidemia, coronary artery disease, mitral insufficiency, atrial fibrillation, renal, hyperhomocysteinemia, etc.).

ACKNOWLEDGEMENTS

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