Measure of Lacunar Counts and Volumes In Participants with Bilateral Stenosis from the Canadian Atherosclerosis Imaging Network (CAIN)

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BACKGROUND

- Lacunes are CSF-filled cavities that range between 3-15mm in diameter [1]
- Lacunes appear hypointense on T1 weighted MRI [1]
- There is no standard method of quantifying lacunar burden
- Volumes and counts may be inaccurate measurements of lacunar burden independently
- It remains unclear how large vessel disease may effect end-organ functioning
- The association of carotid stenosis with small vessel disease requires investigation. [2,3]
- High levels of stenosis may result in SVD and tissue damage due to hypoperfusion or microembolism mechanisms.[4]

PURPOSE & HYPOTHESIS

Purpose: To develop a method of measuring lacunar burden incorporating both lacunar counts and volumes and evaluating this method in patients with carotid stenosis.

Hypothesis: The metric will be a more accurate representation of trends in lacunar burden than considering counts and volume individually. A higher lacunar burden may occur in those participants with stenosis or other cerebrovascular risk factors.

METHODS

1. A modified version of Lesion Explorer (LE) [5] was used to automatically segment cerebrospinal fluid (CSF) intensity regions within the WM and subcortical grey matter (GM) using T2-weighted MRI.
2. The number of CSF intense regions were counted, with the Basal ganglia SABRE [6] regions excluded to avoid inclusion of probably VR spaces.
3. Counts were divided into small and large categories of lacunes <3mm and >3mm in diameter based on a spherical assumption
4. Participants were categorized as having bilateral stenosis if they had both left and right ratings of >50% stenosis

SUBJECTS

All subjects were taken from the Canadian Atherosclerotic Imaging Network study and underwent brain and carotid MRI imaging. See demographic table for more information

IMAGING

Figure 1: Axial T1 weighted MRI displaying variability in size of periventricular black hole counts

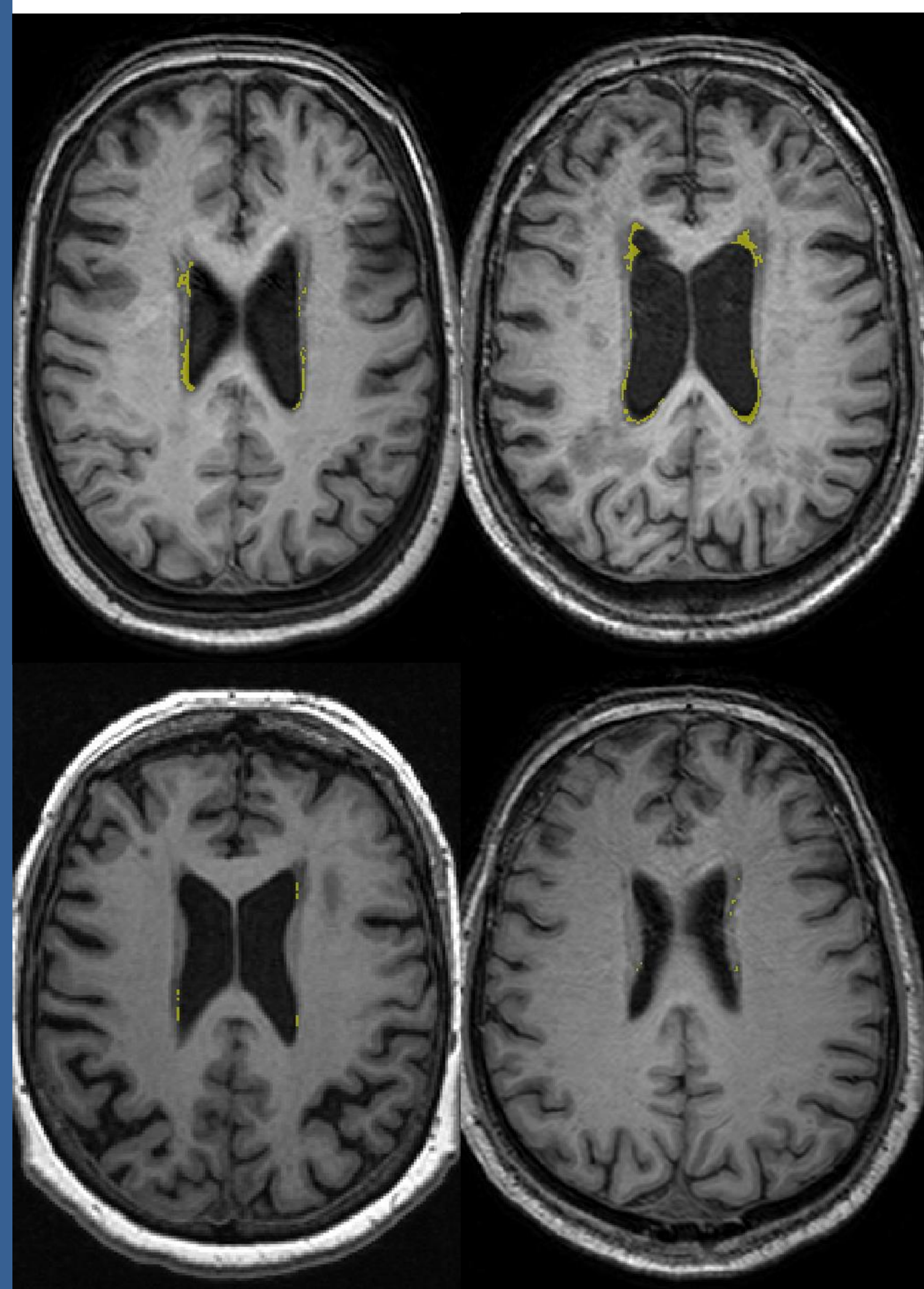

Figure 2: Axial T1 weighted MRI displaying inaccurate inclusion of Virchow-Robins spaces

ANALYSIS

- Non-parametric data were log-transformed
- MANCOVAs were performed to analyze the effects of stenosis, age and gender on counts and volumes of lacunar burden
- Counts were divided into large and small categories as well as periventricular and deep-white black holes
- Counts and volumes were weighted more heavily on those lesions >3mm in diameter

RESULTS

Table 1. Demographic and raw volume data for participants with and without stenosis

	Bilateral Stenosis		
	Yes (n=40)	No (n=53)	p
Demographics			
Age	74.50 (8.99)	74.23 (9.01)	n.s.
Sex, n(%) male	24 (60)	30 (56.6)	n.s.
Volumetrics			
TIC	1258.70 (113.28)	1225.22 (113.64)	n.s.
BPF	78.69 (4.74)	78.37 (3.71)	n.s.
Volume_GM	557.33 (44.72)	544.00 (49.99)	n.s.
Volume_WM	423.97 (62.30)	411.01 (55.65)	n.s.
Volume_sCSF	231.34 (55.17)	227.94 (44.10)	n.s.
Volume_vCSF	37.45 (17.52)	37.24 (16.90)	n.s.
Lacunes	270.55 (571.33)	139.98 (299.83)	n.s.

Table 2. MANCOVA comparing lacunar counts and volumes for subjects with and without bilateral stenosis

	Bilateral Stenosis		
	Yes (n=40)	No (n=53)	p
Volumes			
pvBH Volume <3mm	51.46 (73.91)	55.61 (64.87)	n.s.
pvBH Volume >3mm	174.84 (484.29)	69.34 (169.47)	n.s.
dBH Volume <3mm	16.20 (70.27)	3.25 (6.18)	n.s.
dBH volume >3mm	17.12 (76.68)	1.98 (6.48)	n.s.
Total Volume <3mm	67.66 (114.50)	58.86 (66.97)	n.s.
Total Volume >3mm	191.97 (496.16)	71.33 (169.55)	n.s.
Total Volume	259.63 (592.26)	130.18 (224.28)	n.s.
Weighted Volume	225.80 (543.32)	100.76 (195.97)	n.s.
Counts			
Count <3mm	34.28 (48.12)	31.17 (34.32)	n.s.
Count >3mm	1.87 (4.05)	1.55 (2.76)	n.s.
Total Count	36.15 (51.30)	32.72 (36.69)	n.s.
Weighted Count	19.01 (27.30)	17.13 (19.56)	n.s.

DISCUSSION

- This study suggests that accounting for both lacunar counts and volumes may give a more representative picture of lacunar burden than considering the two individually.
- There was not a significant relationship between lacunar burden and bilateral stenosis in this sample.
- Neither periventricular nor deep white lacunes greater than or less than 3mm were significantly different in either population.
- Limitations including the assumption of lacunes as spherical and the possible inclusion of VR spaces.
- Further refinement of stenosis quantification would allow for more accurate categorization.
- Further study should involve optimizing the use of the size cut-off and complete VR segmentation to ensure their removal.
- The protocol could also be extended to generate counts for VR spaces in order to study the mechanisms of VR counts separately from lacunar counts.

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REFERENCES

1. Wardlaw,,J (2008) What is a Lacune? Stroke. 39;2921-2922
2. Enzinger C, Ropele S, Gattringer T, Langkammer C, Schmidt R, Fazekas F. (2010) High-Grade Internal Carotid Artery Stenosis and Chronic Brain Damage: A Volumetric Magnetic Resonance Imaging Study. Cerebrovascular Disease. 30:540-546
3. Kandiah N, Goh O, Mak E, Marmin M, Ng A. (2012)Carotid Stenosis: A Risk Factor for Cerebral White-Matter Disease. Journal of Stroke and Cerebrovascular Diseases. 23:136-139
4. Momjian-mayor I, Baron JC. (2004) The pathophysiology of Watershed Infarction in Internal Carotid Artery Stenosis. Stroke. 36:567-577
5. Ramirez J, Gibson E, Quddus A, Lobaugh NJ, Feinstein A, Levine B, Scott CJ, Levy-Cooperman N, Gao FQ, Black SE (2011) Lesion Explorer: A comprehensive segmentation and parcellation package to obtain regional volumetrics for subcortical hyperintensities and intracranial tissue. Neuroimage 54: 963-973
6. Dade LA, Gao FQ, Kovacevic N, Roy P, Rockel C, O'Toole CM, Lobaugh NJ, Feinstein A, Levine B, Black SE (2004) Semiautomatic brain region extraction: a method of parcellating brain regions from structural magnetic resonance images. Neuroimage 22: 1492-1502

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