I. BACKGROUND

- Post-stroke cognitive impairment is a very common finding in patients with focal brain infarction, affecting up to 2/3 of stroke survivors.
- Neuropsychological testing in this population generally shows greater executive function impairment than memory impairment, especially in mild cases.
- Executive function in ischemic stroke patients also derived volumes were divided by supra. All testing scores were predicted by age. Years of education did not predict any testing scores.

II. OBJECTIVES

To examine the relationship between normal appearing tissue volumes and cognitive functions in patients with chronic focal brain infarction.

III. METHODS

Participants:
- 59 subjects, 6-36 months post-infarct
- All subjects were administered
  1. The 60 minute protocol (VCI-60min).
  2. The 30 minute protocols (VCI-30min)
  3. Montreal Cognitive Assessment (MoCA).MRI: within 3 weeks of neuropsychological testing.

MR Technique:
- GE, 3-Tesla (3D-T1, T2/FLAIR).

1. Brain tissue segmentation (FIGURE1)
- Semi-automated brain extraction (SABRE).
- Segments into Gray matter (GM), White matter (WM), ventricular & sulcal CSF, and WMH.

2. Infarction tracing (FIGURE2)
- Focal infarcts were visually identified and manually traced on axial T1 including the per-infarct hyper-intensity. (FLAIR & PD/T2 coregistered to T1)

Used ANALYZE 6.0 or ITK-snap.

3. Brain parenchymal fraction (BPF)
- BPF = Normal appearing WM (NAGM) + Normal appearing GM (NAGM).
- All derived volumes were divided by supratentorial total intracranial capacity (STIC) to correct for individual head size (normalized brain volume).

Neuropsychological testing:
- The VCI-60min & VCI-30min tested executive, language, visuospatial, and memory functions.
- Z scores were computed for both protocols, each domain, and MoCA.

Statistical Analysis:
- Multiple regression modeling forced entry of age and education first, and then assessed brain volumetric measures to predict scores on MoCA, VCI-60min, VCI-30min, and each domain.

IV. RESULTS

TABLE1. Demographic and Brain-MRI variables

<table>
<thead>
<tr>
<th>Variables (N=59)</th>
<th>Mean ± SD (median, range)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (years)</td>
<td>65.0 ± 13.0 (62, 45-89)</td>
</tr>
<tr>
<td>Stroke side (L/R)</td>
<td>32 / 27</td>
</tr>
<tr>
<td>MMSE</td>
<td>27.2 ± 3.0 (28, 20-30)</td>
</tr>
<tr>
<td>MRI</td>
<td></td>
</tr>
<tr>
<td>STIC (cm³)</td>
<td>1208 ± 136</td>
</tr>
<tr>
<td>BPF (cm³)</td>
<td>899.6 ± 116.0</td>
</tr>
<tr>
<td>Infarct volume (cm³)</td>
<td>29.3 ± 51.9</td>
</tr>
<tr>
<td>WMH (cm³)</td>
<td>11.5 ± 20.1</td>
</tr>
</tbody>
</table>

STIC-total intracranial capacity; BPF-Brain parenchymal fraction

TABLE2. Multiple regression analysis:

- All testing and domain scores were predicted by age except for visuospatial performance.
- Years of education did not predict any testing scores.
- Blue boxes indicate significant association with the brain volumetric measurement themselves.
- Purple boxes indicate the measurements improve the model over age effects alone.

<table>
<thead>
<tr>
<th>Predictors</th>
<th>MoCA</th>
<th>VCI-60min</th>
<th>VCI-30min</th>
<th>Executive</th>
<th>Language</th>
<th>Visuospatial</th>
<th>Memory</th>
</tr>
</thead>
<tbody>
<tr>
<td>BPF (NAGM+WM)</td>
<td></td>
<td>b=0.41†</td>
<td>b=0.41†</td>
<td>b=0.41†</td>
<td>b=0.27*</td>
<td>b=0.11</td>
<td></td>
</tr>
<tr>
<td>NAGM</td>
<td></td>
<td>R²=0.19†</td>
<td>R²=0.19†</td>
<td>R²=0.19†</td>
<td>R²=0.19†</td>
<td>R²=0.19†</td>
<td></td>
</tr>
<tr>
<td>NAWM</td>
<td></td>
<td>R²=0.20†</td>
<td>R²=0.20†</td>
<td>R²=0.20†</td>
<td>R²=0.20†</td>
<td>R²=0.20†</td>
<td></td>
</tr>
<tr>
<td>NAGM_Left</td>
<td></td>
<td>R²=0.24†</td>
<td>R²=0.24†</td>
<td>R²=0.24†</td>
<td>R²=0.24†</td>
<td>R²=0.24†</td>
<td></td>
</tr>
<tr>
<td>NAGM_Right</td>
<td></td>
<td>R²=0.29†</td>
<td>R²=0.29†</td>
<td>R²=0.29†</td>
<td>R²=0.29†</td>
<td>R²=0.29†</td>
<td></td>
</tr>
<tr>
<td>NAWM_Left</td>
<td></td>
<td>R²=0.37†</td>
<td>R²=0.37†</td>
<td>R²=0.37†</td>
<td>R²=0.37†</td>
<td>R²=0.37†</td>
<td></td>
</tr>
<tr>
<td>NAWM_Right</td>
<td></td>
<td>R²=0.43†</td>
<td>R²=0.43†</td>
<td>R²=0.43†</td>
<td>R²=0.43†</td>
<td>R²=0.43†</td>
<td></td>
</tr>
</tbody>
</table>

MoCA, Montreal Cognitive Assessment; NAGM, total of NAGM in the left hemisphere; NAGM_Right, total of NAGM in the right hemisphere; NAWM_Left, total of NAWM in the left hemisphere; NAWM_Right, total of NAWM in the right hemisphere; * p<0.05; † p<0.01; ‡ p<0.001

V. DISCUSSION & CONCLUSIONS

- This study demonstrates that BPF including NAWM was strongly associated with MoCA total score as well as VCI Harmonization 60 & 30 Minute batteries, in which executive and visuospatial functions showed similar associations after accounting for age.
- NAGM itself did not show any significant association.
- Language function was predicted only by left residual NAM and memory was predicted only by total NAWM. Right NAWM only showed contribution to visuospatial function.
- Expected laterality was seen in language (left) and visuospatial (right) function only in WM.
- Residual NA tissue on MRI may be more important in predicting post-stroke cognition, more so than NAGM alone or tissue lost due to infarct damage.
- WM connectivity appears more important than remaining GM in cognitive correlations.
- Healthy white matter changes may be important for understanding brain behaviors relations post-stroke.

References: