SUBCORTICAL HYPERINTENSITIES: CORRESPONDENCE BETWEEN VOLUMETRICS AND VISUAL RATING ASSESSMENTS.

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BACKGROUND

Subcortical hyperintensities (SH) are commonly observed radiological entities on T2, PD, and FLAIR MRI in the elderly. While their etiology is not fully understood, the presence of SH is believed to indicate some form of small vessel disease [1,2]. Although there are numerous visual rating scales which can be used to quickly assess SH load, volumetric quantification using MRI-based segmentation tools are increasing in availability.

PURPOSE

To assess the correspondence of 2 popular SH visual rating scales with head size corrected volumetrics using an MRI-derived segmentation tool. Scores from the Age-Related White Matter Changes (ARWMC) [3] and Fazekas [4] rating scales were correlated with SH volumes obtained using the Lesion Explorer (LE) image processing pipeline [5,6], in a random sample of mixed dementia patients and normal elderly controls.

RESULTS/DISCUSSION

Spearman correlation coefficients were high for ARWMC score with SH volume (rho=0.85, p<0.0001), and Fazekas score with SH volume (rho=0.87, p<0.0001) across the dementias. Fazekas periventricular (pv) and deep white (dw) scores were also highly correlated when compared with pvSH and dwSH volumes (pv: rho=0.73; dw: rho=0.71). Correlation was high between ARWMC and Fazekas (rho=0.88, p<0.0001).

Variability of SH volumetrics increased as rating scale scores increased (see Fig.1). Additionally, higher variability was shown for ARWMC scores from FTD (SD=8.3) and DLB/PDD±AD (SD=6.9) compared to AD±SVD (SD=4.3) and NC (SD=3.8).

Conclusion: As demonstrated in previous studies [7,8], a ceiling effect was observed in visual rating scales. Given the increased variability of SH volumes with higher visual ratings scores, volumetric measures are recommended when studying mixed dementia populations with a vascular component.

RESULTS

Table 1 – Participant demographics, visual rating scale scores and volumetric imaging summary statistics.

	AD±SVD	DLB/PDD±AD	FTD	MCI	NC	VCD
Demographics						
n	70	6	3	3	24	23
Age, y	71.7 (9.7)	66.3 (8.8)	73.7 (3.1)	78.0 (8.2)	70.1 (7.7)	78.1 (8.2)
Sex, n (%) female	34 (49)	5 (83)	2 (67)	3 (100)	15 (62)	14 (61)
Education, y	13.9 (3.9)	14.2 (2.3)	15.3 (3.5)	13.7 (2.1)	15.5 (2.7)	14.3 (4.1)
Visual Rating of SH						
ARWMC	5.0 (4.3)	6.5 (6.9)	8.7 (8.3)	9.0 (4.4)	4.1 (3.8)	14.7 (4.3)
Fazekas[a]	2.5 (1.4)	3.0 (4.2)	4.0	3.0 (1.0)	1.2 (1.0)	4.6 (1.3)
Fazekas pvSH	1.3 (0.7)	1.5 (2.1)	3.0	1.3 (0.6)	0.6 (0.7)	2.4 (0.9)
Fazekas dwSH	1.17 (0.8)	1.5 (2.1)	1.0	1.7 (0.6)	0.6 (0.5)	2.2 (0.9)
SH Volumetrics[b]						
SH	9.2 (11.5)	17.0 (25.2)	18.1 (21.1)	8.7 (5.8)	4.6 (5.7)	36.3 (20.3)
pvSH	8.2 (11.1)	16.1 (24.1)	17.8 (20.4)	6.8 (5.0)	3.6 (5.0)	34.0 (20.2)
dwSH	0.9 (1.4)	0.9 (1.1)	0.4 (0.7)	1.9 (1.7)	1.0 (3.2)	2.3 (2.5)
Lacunar (mm^3)	105.5 (215.0)	310.5 (529.0)	30.7 (34.5)	21.0 (2.6)	39.25 (89.3)	1378.1 (2622.2)

Values reported are mean (SD) unless otherwise specified.
Key: ARWMC= Age-Related White Matter Changes scale, SH=subcortical hyperintensities, pvSH=periventricular SH, dwSH=deep white SH.
[a] Available in 47 AD±SVD, 2 DLB/PDD±AD, 1 FTD, 3 MCI, 15 NC, and 8 VCD participants.
[b] All volumes were head-size corrected and expressed in cubic centimetres (cc) unless otherwise indicated.

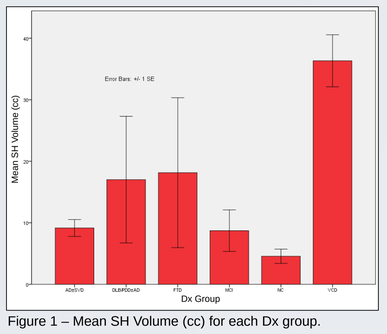

Figure 1 – Mean SH Volume (cc) for each Dx group.

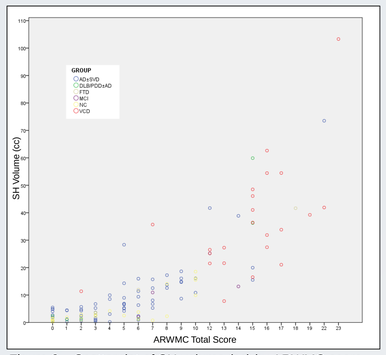

Figure 2 – Scatterplot of SH volume (cc) by ARWMC score.

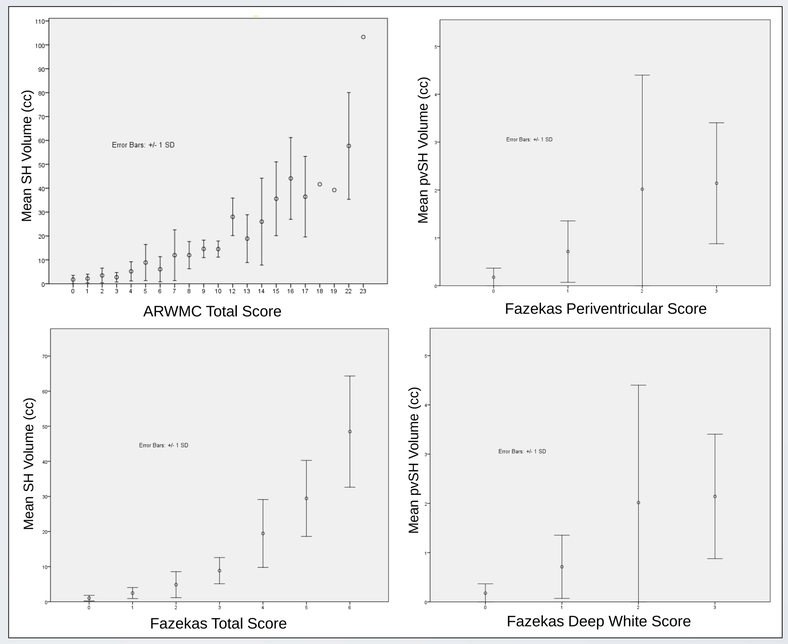

Figure 3 – Graphs showing mean SH volume (cc) by ARWMC score (top left), Fazekas Total Score (bottom left), mean pvSH volume by Fazekas periventricular rating (top right), and mean dwSH volume by Fazekas deep white rating (bottom right).

METHODS

PARTICIPANTS

Participants were randomly sampled from the Sunnybrook Dementia Study and included a mix of dementia and normal elderly: AD with varying degrees of small vessel disease (AD±SVD), Parkinson/Lewy-Body spectrum disease (DLB/PDD±AD=6), Fronto-Temporal lobar degeneration (FTD=3), Mild Cognitive Impairment (MCI=3), normal elderly controls (NC=24) and vascular cognitive disorder (VCD=23). See Table 1 for additional details.

MRI PROCEDURES

MRI Protocols: 1.5T GE Signa. T1-weighted (AX 3D SPGR, 1.2-1.4mm), proton density (PD) and T2-weighted (T2) (interleaved axial dual-echo spin echo, 3mm).

LE was used to obtain SH volumetrics [5,6]; ARWMC and Fazekas ratings were performed by a research radiologist.

LESION EXPLORER

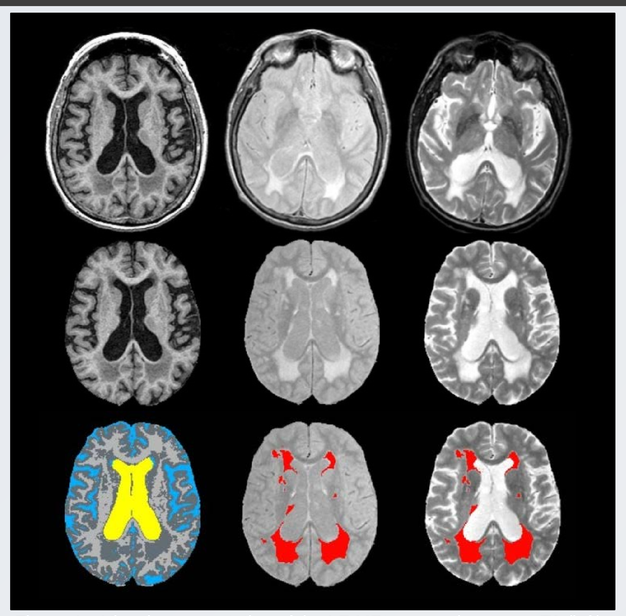

Figure 4 – Visual representation of the LE MRI processing steps. T1 (left), PD (middle), and T2 (right), with SH segmentation overlayed in red.

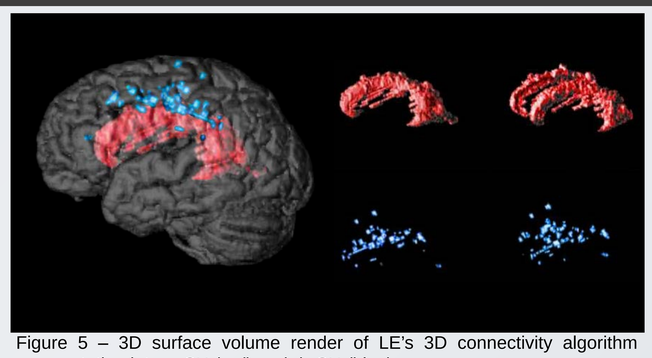

Figure 5 – 3D surface volume render of LE's 3D connectivity algorithm segmentation into pvSH (red) and dwSH (blue).

The LE pipeline was applied to coregistered T1, PD and T2 images. Quantification of SH was accomplished from a T1/PD/T2 segmentation using localized intensity histograms and a fuzzy clustering false positive minimization procedure to obtain pvSH, dwSH, and lacunar volumes. Segmentation of SH into pvSH and dwSH was accomplished using a 3D connectivity algorithm (see Figure 5 above).

ACKNOWLEDGEMENTS

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