

Consensus paper

Purpose

Primary: continuous scale for grading SVD burden.

Secondary: risk stratification of new stroke, dementia.

Scoring

MRI features	ENIGMA SVD score
Number of microbleeds (SWI)	
0	0
1	1
2-4	2
5-10	3
>10	4
Location of microbleeds – no points (SWI)	
Lobar, deep, or infratentorial (choose one or more)	L/D/I
Superficial siderosis (SWI)	
No siderosis	0
1 sulcus	1
>1 sulcus	2
Lacunes (3D FLAIR)	
0	0
1–2	1
3–5	2
>5	3
White matter hyperintensities – see Figure 1 (3D FLAIR)	
Absent	0
Punctate foci	1
Beginning confluence	2
Large confluent areas	3
Atrophy – see Figure 2 (3D T1)	
No	0
Mild	1
Moderate	2
Severe	3
Total SVD score	0-15

Setting

Patients were scanned on clinical MR scanners as part of the clinical acute evaluation of stroke patients. Patients were included between 2013-2022 on a variety of scanners with different field forces and scanned with different algorithms.

Scoring is performed independently by a neurologist and a neuroradiologist and consensus as achieved if needed.

Definitions on biomarkers

Definitions are mainly according to the STRIVE v1 criteria,(Wardlaw et al., 2013) but also with local specifications.

Microbleeds

Sequence: SWI / T2*

Small (generally 2–5 mm in diameter, but sometimes up to 10 mm) areas of signal void with associated blooming seen on SWI-weighted MRI.

Different cut-offs are used in different trials. (Akoudad et al., 2016) We try to register in a way, so that our analysis can be made similarly to other studies and to provide enough resolution.

As discussions about the importance of location is ongoing,(Vernooij et al., 2008) we register if microbleeds are located lobar, deep, or infratentorial.

Superficial siderosis

Sequence: SWI / T2*

“Investigators should describe the location of siderosis (i.e., the number of sulci involved and in which lobes).”(Wardlaw et al., 2013, p. 828)

Lacunes

Sequence: 2D / 3D FLAIR

“A round or ovoid, subcortical, fluid-filled cavity (signal similar to CSF) of between 3 mm and about 15 mm in diameter, consistent with a previous acute small subcortical infarct or haemorrhage in the territory of one perforating arteriole.”(Wardlaw et al., 2013, p. 825)

Additionally:

“We identified asymptomatic lacunar infarcts as sharply demarcated hyperintense lesions ~~<20 mm~~ on T2-weighted images with corresponding hypointense lesions with a hyperintense rim on FLAIR. In lacunar stroke patients, the lesion could not be compatible with the clinical stroke.”(Huijts et al., 2013)

White matter hyperintensities

Sequence: 2D / 3D FLAIR

The Fazekas subscale for deep white matter is used. The scale divides the white matter in periventricular and deep white matter, and each region is given a grade depending on the size and confluence of lesions.(Gaillard, n.d.)

No regional differences is noted.(de Groot et al., 2000) Scoring is performed with visual reference, see Figure 1 Fazekas score.

Atrophy

Sequence: 3D T1

We follow definitions for the Global Cerebral Atrophy (GCA) score.(Harper et al., 2015)

A picture sample for reference is used, see Figure 2 Generalised GCA scale.

~~Enlarged perivascular space~~

~~Sequence: 3D FLAIR~~

~~Debated whether this measure is clinically important. We register presence or not from 3D FLAIR, and only in the basal ganglia, which is not optimal anyways. (Benjamin et al., 2018; Hilal et al., 2018; MacLulich et al., 2004; Olama et al., 2020)~~

Referencer

Akoudad, S., Wolters, F. J., Viswanathan, A., de Bruijn, R. F., van der Lugt, A., Hofman, A.,

Koudstaal, P. J., Ikram, M. A., & Vernooij, M. W. (2016). Association of Cerebral

Microbleeds With Cognitive Decline and Dementia. *JAMA Neurology*, 73(8), 934–943.

<https://doi.org/10.1001/jamaneurol.2016.1017>

Benjamin, P., Trippier, S., Lawrence, A. J., Lambert, C., Zeestraten, E., Williams, O. A., Patel,

B., Morris, R. G., Barrick, T. R., MacKinnon, A. D., & Markus, H. S. (2018). Lacunar

Infarcts, but Not Perivascular Spaces, Are Predictors of Cognitive Decline in Cerebral

Small-Vessel Disease. *Stroke*, 49(3), 586–593.

<https://doi.org/10.1161/STROKEAHA.117.017526>

de Groot, J. C., de Leeuw, F. E., Oudkerk, M., van Gijn, J., Hofman, A., Jolles, J., & Breteler, M.

M. (2000). Cerebral white matter lesions and cognitive function: The Rotterdam Scan

Study. *Annals of Neurology*, 47(2), 145–151. [https://doi.org/10.1002/1531-](https://doi.org/10.1002/1531-8249(200002)47:2<145::aid-ana3>3.3.co;2-g)

[8249\(200002\)47:2<145::aid-ana3>3.3.co;2-g](https://doi.org/10.1002/1531-8249(200002)47:2<145::aid-ana3>3.3.co;2-g)

Gaillard, F. (n.d.). *Fazekas scale for white matter lesions* | *Radiology Reference Article* |

Radiopaedia.org. Radiopaedia. Retrieved 4 February 2022, from

<https://radiopaedia.org/articles/fazekas-scale-for-white-matter-lesions?lang=us>

Harper, L., Barkhof, F., Fox, N. C., & Schott, J. M. (2015). Using visual rating to diagnose

dementia: A critical evaluation of MRI atrophy scales. *Journal of Neurology,*

Neurosurgery & Psychiatry, 86(11), 1225–1233. [https://doi.org/10.1136/jnnp-2014-](https://doi.org/10.1136/jnnp-2014-310090)

[310090](https://doi.org/10.1136/jnnp-2014-310090)

Hilal, S., Tan, C. S., Adams, H. H. H., Habes, M., Mok, V., Venketasubramanian, N., Hofer, E.,

Ikram, M. K., Abrigo, J., Vernooij, M. W., Chen, C., Hosten, N., Volzke, H., Grabe, H. J.,

- Schmidt, R., & Ikram, M. A. (2018). Enlarged perivascular spaces and cognition: A meta-analysis of 5 population-based studies. *Neurology*, 91(9), e832–e842.
<https://doi.org/10.1212/WNL.0000000000006079>
- Huijts, M., Duits, A., van Oostenbrugge, R. J., Kroon, A. A., de Leeuw, P. W., & Staals, J. (2013). Accumulation of MRI Markers of Cerebral Small Vessel Disease is Associated with Decreased Cognitive Function. A Study in First-Ever Lacunar Stroke and Hypertensive Patients. *Frontiers in Aging Neuroscience*, 5, 72.
<https://doi.org/10.3389/fnagi.2013.00072>
- MacLulich, A. M. J., Wardlaw, J. M., Ferguson, K. J., Starr, J. M., Seckl, J. R., & Deary, I. J. (2004). Enlarged perivascular spaces are associated with cognitive function in healthy elderly men. *Journal of Neurology, Neurosurgery & Psychiatry*, 75(11), 1519–1523. <https://doi.org/10.1136/jnnp.2003.030858>
- Olama, A. A. A., Wason, J. M. S., Tuladhar, A. M., Leijssen, E. M. C. van, Koini, M., Hofer, E., Morris, R. G., Schmidt, R., Leeuw, F.-E. de, & Markus, H. S. (2020). Simple MRI score aids prediction of dementia in cerebral small vessel disease. *Neurology*, 94(12), e1294–e1302. <https://doi.org/10.1212/WNL.0000000000009141>
- Vernooij, M. W., Lugt, A. van der, Ikram, M. A., Wielopolski, P. A., Niessen, W. J., Hofman, A., Krestin, G. P., & Breteler, M. M. B. (2008). Prevalence and risk factors of cerebral microbleeds: The Rotterdam Scan Study. *Neurology*, 70(14), 1208–1214.
<https://doi.org/10.1212/01.wnl.0000307750.41970.d9>
- Wardlaw, J. M., Smith, E. E., Biessels, G. J., Cordonnier, C., Fazekas, F., Frayne, R., Lindley, R. I., O'Brien, J. T., Barkhof, F., Benavente, O. R., Black, S. E., Brayne, C., Breteler, M., Chabriat, H., DeCarli, C., de Leeuw, F. E., Doubal, F., Duering, M., Fox, N. C., ...

Dichgans, M. (2013). Neuroimaging standards for research into small vessel disease and its contribution to ageing and neurodegeneration. *The Lancet Neurology*, 12(8), 822–838. [https://doi.org/10.1016/S1474-4422\(13\)70124-8](https://doi.org/10.1016/S1474-4422(13)70124-8)

Visual guides

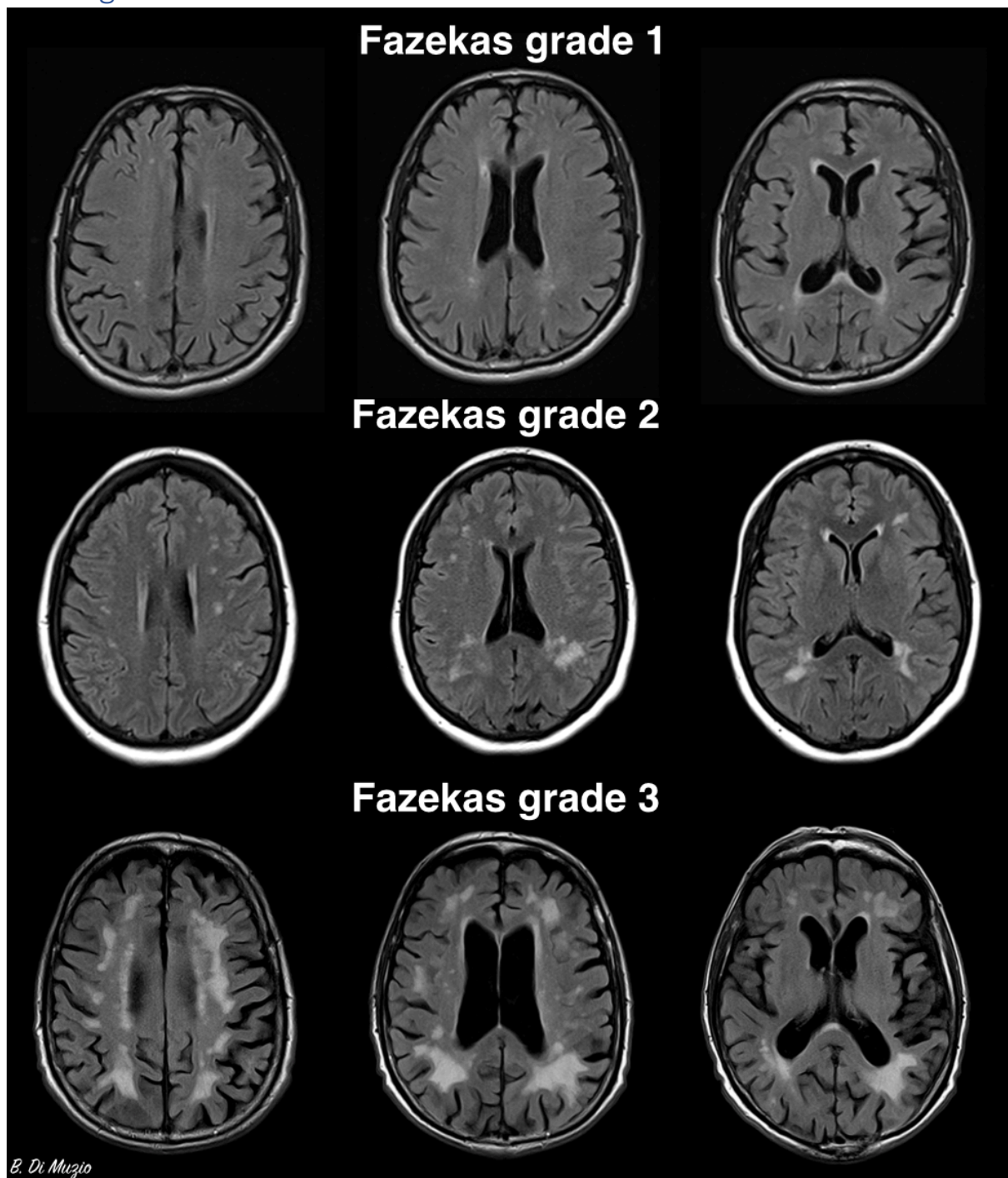


Figure 1 Fazekas score

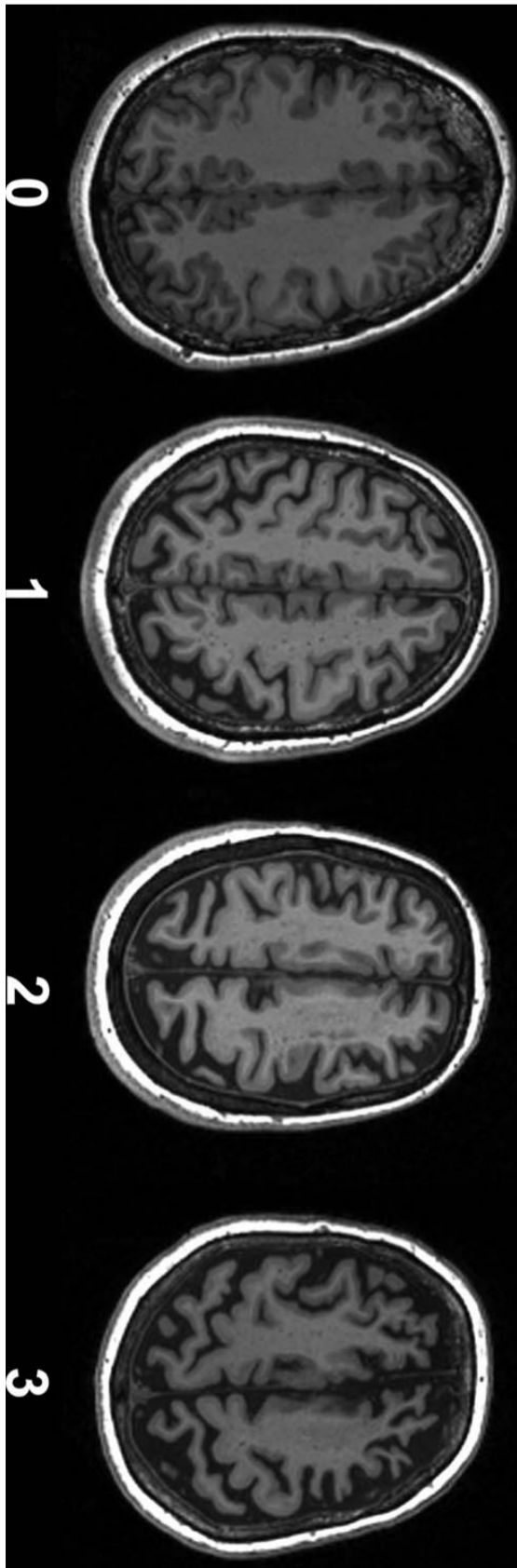


Figure 2 Generalised GCA scale

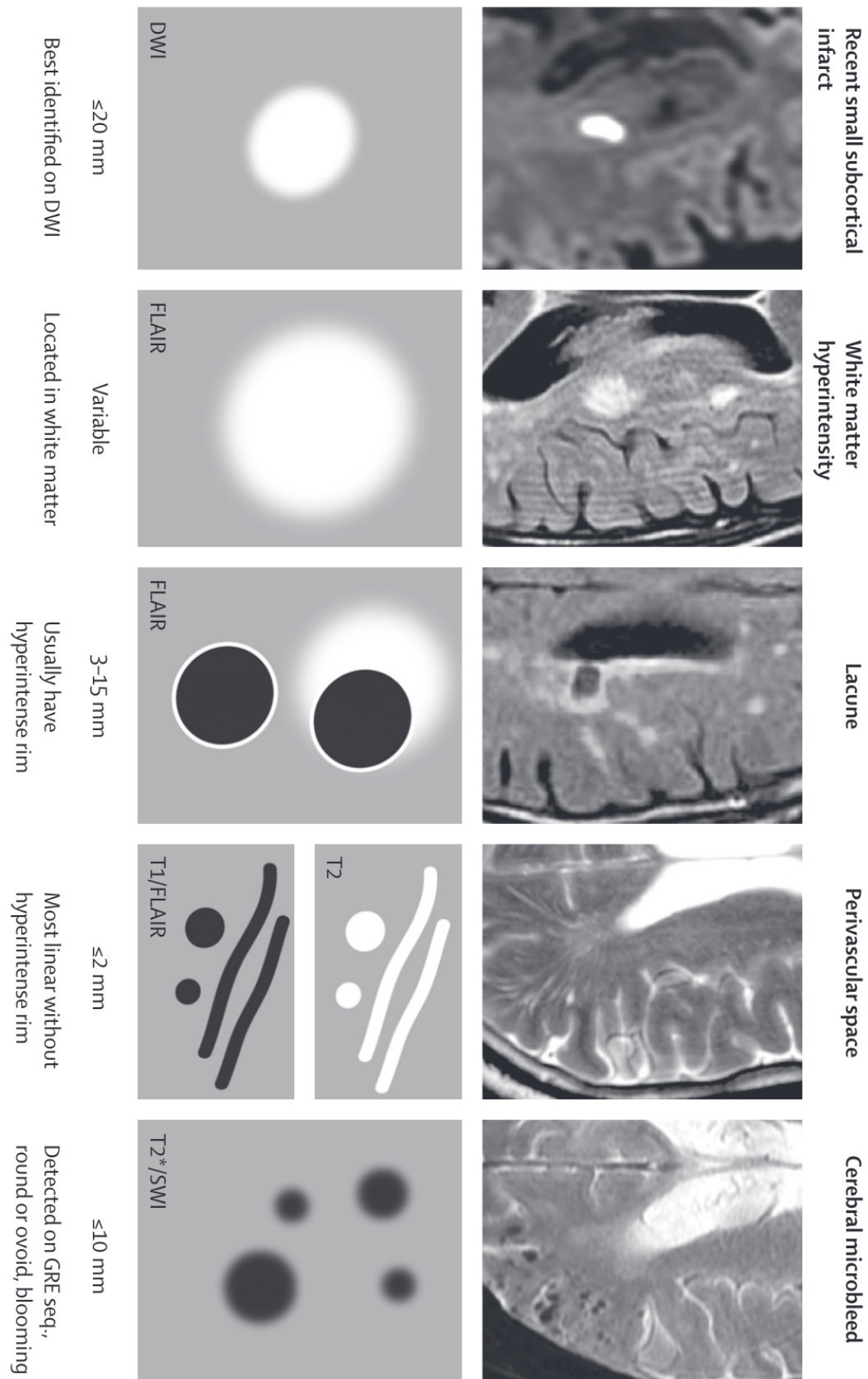


Figure 3 Overview from Wardlaw et al, 2013